APPENDIX A

Final Panel Comments

on the
Final Independent External Peer Review Report
St. Johns Bayou and New Madrid Floodway, MO,
Consolidated NEPA Document and Work Plan
Environmental, Economic, and Hydrologic and Hydraulic Review

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Comment 1:
The cumulative impacts section lacks specific information on the incremental impacts of the proposed project.
Basis for Comment:
Cumulative impact is defined as the impact on the environment that results from the incremental impact of the proposed project when added to other past, present, and reasonably foreseeable future actions. In assessing cumulative impact, there are two factors that should be considered: (1) the unique characteristics of the geographic area and (2) whether the action is related to other actions with individually insignificant but cumulatively significant impacts on the environment. The project area is considered to be unique because only approximately 50,000 acres remains of an original 2.5 million acres of forested wetlands in southeast Missouri (Page 232). Also, according to the U.S. Fish and Wildlife Service (Page 260), the New Madrid Floodway is the last remaining connection of the Mississippi River with its historic floodplain in Missouri. In the opinion of the panel, these unique aspects, and the importance of annual flooding in maintaining the remaining natural refugia, increase the probability that additional incremental losses will be cumulatively significant. The Consolidated NEPA Document provides a descriptive historical account of the St. Johns Bayou and New Madrid Floodway, along with statistics on acres of present land uses, but does not provide analysis of the incremental impacts of the proposed project within the context of the cumulative loss of wetlands and river-floodplain connections in the lower Mississippi River Basin. According to the Council on Environmental Quality (1997), the unique requirements of cumulative effects analysis (i.e., the focus on resource sustainability and the expanded geographic and time boundaries) must be addressed by developing an appropriate conceptual model. This conceptual framework should constitute a general causal model of cumulative effects that incorporates information on the causes, processes and effects involved. The cumulative impacts section of the Consolidated NEPA Document lacks such an overall conceptual framework. References Council on Environmental Quality. 1997. Considering Cumulative Effects under the National Environmental Policy Act. Washington, D.C. January 1997.
Significance – High:
An accurate assessment of cumulative effects is essential to avoiding and minimizing adverse consequences, and developing an adequate compensatory mitigation strategy.
Recommendations for Resolution:
To resolve these concerns, the project needs to consider the following: ▪ Develop an overall conceptual framework that incorporates information on causes, processes and effects. ▪ Identify cause-effect relationships relevant to the proposed project. ▪ Utilize available information on biotic indices (e.g., habitat suitability, diversity, etc.) and landscape conditions (e.g., habitat fragmentation) as benchmarks of accumulated change over time. ▪ Utilize remote sensing and GIS methods to quantitatively assess historical changes in land uses and habitats.

Comment 2:
Baseline agricultural economic conditions are not adequately supported with evidence, nor are the predicted future economic benefits associated with the project.
Basis for Comment:
The Consolidated NEPA Document maintains that current agricultural production is suboptimal and that the project will add benefits. There is no evidence provided in the reports that current production is suboptimal. Optimal production occurs either when profits are maximized given current conditions, or at least that costs are minimized given current conditions. Farmers who live in regions that experience frequent floods have very likely already fully adapted to flooding conditions. There are also a host of federal assistance or relief packages and insurance that they might be taking advantage of, which help offset any losses due to flooding. The report does not document whether or not farmers in the area have already taken flooding risks into account and are already optimizing their production activities, thus it does not include sufficient evidence that the project will add agricultural benefits. The main assumption made that underlies the claim that the project will contribute benefits to agriculture is that farmers plant low valued crops when there is a probability of flooding, but would switch to higher valued crops when flood risks are reduced (see Appendix B, p. B5, B6). There is mention of crop budgets (p. B6), but no documentation of the costs involved with planting and harvesting different crops, and the assumption is not supported with evidence. The regression results at p. B6 are not adequately explained, nor defined. The usual reported statistic is the goodness of fit, or R^2, but this is not reported on that page, although simple correlation coefficients are. Many studies have suggested that farmers behave in a fashion consistent with them being risk averse (e.g. Bingswanger, H.P. (1981)). While aversion to risk is one possible risk attitude, other people are risk neutral (i.e. they are indifferent between choosing to play a 50-50 gamble that pays either $1.00 or nothing, versus being offered $0.50 with certainty), and still others are risk lovers (people who like to gamble: they could be offered more than $0.50 with certainty and still choose the gamble). Risk attitudes for any particular farmer are an empirical issue and thus, risk attitudes for farmers in this region need to be documented before future decisions they might make in response to risk changes can be predicted. This is because farmers with any of the three types of risk attitudes each would behave differently in response to risk changes than farmers of another type. For example, some farmers might already factor in the risk and try to get the profits from high-valued crops under current (before project) conditions, especially if they can get federal disaster or other assistance. Other types of farmers might be unwilling to gamble on planting high valued crops that might be destroyed by a flood, assuming that the cost of planting and harvesting is higher. The economic analysis in the report makes strong assumptions about how cropping patterns will change (switching to crops of different values) with reduced risk. Again here, there is no evidence provided about how farmers would change cropping patterns, in response to risk changes.

Third, there is no detailed analysis of what use producers would make of any additional acreage for agricultural production. The report needs to document that farmers would, for example, plant more rice than they do now, including rice that might be planted on lands acquired in association with mitigation strategies such as those associated with offsetting impacts to shorebirds. Fourth, future benefits depend on how different future crop prices will be from ones used for an analysis, and this cannot be known either. Subsidies for crops and price support programs may be absent, lower or in fact much higher or stronger in future years. As another example, consider what happened to the price of corn and other crops recently, with severe droughts in some areas of the world, coupled with ethanol subsidies that led corn producers to take advantage of them. Global warming in the future may exacerbate the drought problem, and no one knows with certainty what energy supplies will be and how they will relate to bio-fuel production. The panel's literature search in economics and agricultural economics did not locate any convincing studies to link flood risks to agricultural production, so whether farmers would switch from current crops to other ones cannot be known at this juncture, introducing a great deal of uncertainty in the analysis. References Bingswanger, H.P. 1981. Attitudes toward risk: Theoretical implications of an experiment in rural India. *The Economic Journal* 91 (364):867-90.
Significance – High:
The agricultural benefits are almost the sole driver of the project, unless other types of benefits are brought into the analysis, so the agricultural benefits must be clearly calculated, convincing, and large for the project to have a BC ratio that is greater than one.
Recommendations for Resolution:
To resolve these concerns, the project needs to consider the following: ▪ Provide data and evidence that baseline production (current production today), is "suboptimal", i.e. that farmers are not already optimizing in response to flooding conditions. To do so might require reporting of farm profits in the region for lower flooding and higher flooding years. ▪ Document the costs of planting and harvesting different crops that would be profitable in the region. ▪ Provide evidence that crop prices used in the analysis are reasonable in projection of future benefits. ▪ Provide evidence and documentation that farmers will change existing cropping patterns. ▪ Revise the risk analysis to include possible scenarios for future crop prices that prices that depend on world-demand and supply conditions that in turn depend on subsidies, global warming, and energy supply and demand.

Comment 3:
The economic analysis is confusing because it does not follow the standard practice of calculating the present value of future benefits and costs using a single discount rate for the project analysis, and for a well-defined and consistent period of analysis.
Basis for Comment:
Conventional benefit-cost analysis uses one single discount rate (r) to calculate the present value of all future benefits and costs, for a well defined time period (t = 1,…T) associated with the life of the project, ending in the T^{th} year. The discounting procedure is done such that there is no discounting in the very first period, and the discount factor $(=[1/(1+r)]^t)$ is then less than one as each future year is contemplated, thus making benefits or costs smaller, from the point of view of the present. Sensitivity analysis is often performed as a way of accounting for the presence of risk or uncertainty by redoing the entire analysis after it has been done for one discount rate, consistently using a single alternative (lower or higher) discount rate. The Office of Management and Budget (OMB) is the authority that issues a memorandum on the discount rate to be used in analysis of federal projects in the United States. Currently, the OMB recommends a 3% and a 7% rate be used, even though private market decisions often imply much higher rates of discounting. {The economics literature often shows that private decision making is often consistent with individual rates of discount well above 10% (see the summary review paper Frederick et al. (2002).} The Consolidated NEPA Document claims that the project, or at parts of it such as the New Madrid closure levee see page xx – note that "xx" refers to the Roman numeral set of pages that precede the table of contents, section S.9.10.2), are "grandfathered" with respect to the discount rate that could be used. The report suggests that a 2.5% rate of discount can be used (see p. xx), but it is not clear whether the 2.5% could only be used for the New Madrid closure levee, or the entire project. Page B-1 (bottom) and B-2 of Appendix B make it sound like two rates are used. In addition, the use of 2.5% instead of 3% or 7% is a legal issue, and not an economic one, but different discount rates {the report also features some calculations for a rate of about 5.125% (see page 211 of the Consolidated NEPA Document) and at 6.125% - see page 211, and also see B41, Appendix B, for example} cannot be used for some years versus others, or used for some impacts or alternatives, but not others. The report is confusing about which rates are used for which alternatives and parts of the project. The alternative discount rates such as 6.125% are used for sensitivity analysis in connection with the revision to the report (RSEIS 2), but this is not very clear to the reader. Discounting the alternatives at 3 or 7%, but discounting the favored at 2.5% of course gives the favored project the advantage, however, it is not clear whether the levee closure is always incorporated using a 2.5% discount rate, even when it is a feature of the one of the alternatives (p. B-24 of Appendix B suggests this is true). The period of analysis sometimes appears in the report to be 2002 to 2052 (implying a fifty year project life – see page B20, Appendix B, for example) and at other times in the report the initial period seems to be 1997 to some unknown future date (page B-1, Appendix B is not clear about this). The analysis for the report needs to adopt one consistent time period, from the start of

construction, through to a well-defended end to the project. It is not standard practice to compound (inflate) benefits or costs that precede the start date of the project (see page B-1, Appendix B), thus, the start date needs to be consistent with the initial construction phase of the project to provide clarity for the analysis. Finally, it would be best to use the most available, up to date, and relevant information on prices and costs, and inflation rates available at the time of the analysis. Discount rates should reflect society's real rate of time preference, not confounded with inflationary trends, and the report is not clear regarding treatment of inflation rates. References Frederick, S., G. Loewenstein and T. O'Donoghue. 2002. Time Discounting and Time Preference: A Critical Review. *J. of Econ. Literature* Vol. XL, June:351-401.
Significance – High:
The project is close to the point where it would not be considered economical, even when using a low discount rate of 2.5%, as in Table 19 (Appendix B, p. B-25), thus the methods and procedures must be clear, and sound.
Recommendations for Resolution:
To resolve these concerns, the project needs to consider the following: ▪ Provide an analysis using a well-defined period for the project that is consistent for all of the impacts considered, and this should carefully define the actual starting date for construction of the project, its completion, and the end of the project life. ▪ Conduct an analysis of all of the costs and benefits for the project in present value terms using a 3% discount rate, then completely re-estimated using a 7% discount rate. Sections of any future report should be very clear as to which single rate is being used for the analysis that is presented within that section of the report. Separate tables, or at least clearly indicated separate columns or rows of any single table, should label the discount rate used to arrive at this present value. ▪ Conduct a sensitivity analysis for the 2.5% rate, again using only this rate for all benefits and costs, starting from a clear starting date and discounting all future benefits and costs, without compounding any benefits or costs that precede the start date.

Comment 4:
The assumption used to calculate mid-season fish spawning habitat to mitigate winter waterfowl habitat has not been properly evaluated.
Basis for Comment:
Even if winter habitat is emphasized for mitigation of waterfowl, which is an assertion, is not clear how this is possible under the basic mitigation plan. According to Table 2.4 (Page 35, Consolidated NEPA Document), 1,293 acres will be reforested for duck use in the St. Johns Bayou (SJB), 2,326 acres of habitat will be reforested in the New Madrid Floodway (NMF) in addition to the 671 acquired for vegetative buffer and 266 acres acquired for a wildlife corridor. All of these acres are intended to, in part, be used to provide adequate mitigation Duck Use Days (DUDs) by maintaining water at 285 feet during the winter in the St. James Bayou and 284.4 feet in the new Madrid Floodway (tables 2.1 and 2.2). Thus, the basic mitigation plan will require the acquisition of 4,556 acres (summation of the above acreages) of crop and fallow fields (Table 2.4, Page 35, Consolidated NEPA Document), with water being maintained on this habitat during December and January by maintaining water levels at 285 feet and the SJB flood gate and 284.4 feet at the NMF flood gate. The problem is, according to Tables 3.3 and 3.4, Table 2.4 (Pages 58 and 59, Consolidated NEPA Document) there are only 3,174 acres of crop or fallow fields (1,382 acres less than needed) that would be flooded when water is maintained at 285 feet in the SJB and 284.4 in the NMF. Furthermore, flooded is only useful when water levels are ≤ 30 cm; any habitat deeper than 30 cm will not be providing DUDs for waterfowl. Therefore, when water is held in SJB at 285 feet, the only acres available for ducks are the acres that fall between the elevations of 284 and 285, which total 1,472 acres. The only acres available for ducks in the NMF when gates are holding water at 284.4 feet are the acres between elevation 283 and 284 (assumes 0.4 feet is needed for ducks to use it and simplifies the example), which is only 437 acres of crop and fallow fields. This analysis indicates only 1,909 acres of crop and fallow fields are available at the appropriate elevation for potential mitigation. This analysis also assumes the 387 acres for borrow pits will come from acres above or below these elevations. Thus, the basic mitigation plan calls for 4,556 mitigation acres of habitat for waterfowl when only 1,909 acres of crop and fallow fields are available for mitigation (assuming all owners of the 1,909 acres are willing participants). More of these acres could be made available by fluctuating the water levels during winter so different acres were at the appropriate depth at different times, but this would require regular monitoring and regulation of water levels; at considerable additional expense. Even if the much more expensive approach was taken, an additional 1,382 acres that don't exist would be required.
Significance – High:
Mitigation adequate to replace wetlands lost to migratory birds is required for this project to move forward; it is unclear how adequate mitigation could be achieved under current plan.

Recommendations for Resolution:
To resolve these concerns, the project needs to consider the following: ▪ Develop a new mitigation plan needs that will allow flooding at a depth < 30 cm on adequate acreage to mitigate for lost DUDs (at least 4,556 acres according to the Consolidated NEPA Document) due to the altered hydrology produced by the project.

Comment 5:
The proposed basic mitigation features are unlikely to achieve the desired level of wetland compensation.
Basis for Comment:
Federal law (Section 404 Clean Water Act) requires that wetland loss be avoided, minimized or mitigated to achieve no net loss of wetlands. While some of the first two options were incorporated into this project, wetlands will be lost due to direct construction (~170 acres) while considerably more wetlands (up to 13,200 acres) will be affected due to the water control project that, by design, will lessen the amount of flooding that occurs in the study sites (Appendix D, p. D-9). So significant mitigation for wetland loss and particularly loss in wetland function should be required for this project and the mitigation is being done in an area that will have less water flux than before. The Panel believes that, despite the fact that a hydrogeomorphic (HGM) analysis was completed after the 2002 Revised Supplemental Environmental Impact Statement (RSEIS), there remain three issues with the proposed mitigation for wetland loss described for the alternatives in the Consolidated NEPA Document. First the amount of wetland function impacted by the project is probably understated. Second, a description of the mitigation of wetland loss, as described in Appendices D and E and other parts of the Consolidated NEPA Document as reforstation of 8,400 acres of frequently flooded cropland, purchasing of flood easements, development of moist soil units, and wetland restoration/river reconnections in Big Oak Tree State Park, is not provided in sufficient detail nor in a comprehensive manner to allow a determination if the mitigation is sufficient. There does not appear to be a mitigation ratio approaching 1:1 based on wetland area (acreage); if functional attributes of the wetlands are used, there is even less chance that the ratio will be at 1:1 or higher. Third, there is no clearly stated adaptive management plan in the report that would be subject to use after the standard 5-year monitoring. <u>Understated impact</u> The Consolidated NEPA Document states that even though there is a reduction in hydrology as a result of this project, it “does not mean that these lands will lose their wetland character.” The panel believes that floodplain wetlands without river pulses are not the same as wetlands with flood pulsing (see, e.g., Mitsch et al. 2005, 2008; Fink and Mitsch 2007; Hernandez and Mitsch 2006, 2007; Altor and Mitsch 2008; Anderson and Mitsch 2008; Tuttle et al. 2008) even if groundwater and local rainfall cause water level fluctuations. It is not sufficient to have water level; water flux with accompanying nutrients and export capacity are important for many functions. The panel is also concerned about the potential indirect impact of dredging in the St. Johns on the hydrology and subsequent function and value of riparian wetlands. While this may be minor compared to the large-scale impact of indirect effects of the project, the issue appears to be ignored in the Consolidated NEPA Document. The panel knows from other systems that when you reduce the elevation of the main channel, adjacent riparian wetlands are also dried out. <u>Mitigation description</u> The proposed mitigation for wetland loss is not clearly described in the report. To simply state

that agricultural lands will be reforested according to "commonly accepted practices for wetland mitigation projects in the Corps' Memphis District" (Appendix E) is not sufficient, given the importance of this on project success. There are also few details of monitoring beyond required 5 years, there are not any projections of hydroperiods, plant communities, or soils for the mitigation sites at 20 50, and 100 years into this project. The panel believes that the mitigation plan appears to be theoretical more than real.

Reforestation is a reasonable alternative, although the panel suspects that these forests will mostly be on the dry side, given the large-scale drainage that is occurring. They will be expensive to maintain and it is unlikely that trees can be kept out of these sites without constant management.

The panel believes that the mitigation that has the most chance of success is the Big Oak Tree State Park hydrologic restoration. Here, USACE is adding water, not draining. Unfortunately, there are no specifications given (p. 118) on how much water, when, etc. Relying on gravity would of course be optimum, but to ensure success, pumps might have to be installed too. There is more detail given about purchasing the property and the zones of bottomland that are desired (essentially all 4 types of bottomland forest) than about the expected hydrologic regime, which is crucial to the project's success.

Borrow pits may have the most potential of becoming and staying as wetlands for a very long duration as they fill with sediments and organic matter. If half of them are 3 ft deep or less, they can be designed with littoral zones for vegetation and contribute significantly to biodiversity. Ecological engineering help to design these ponds appropriately is needed.

Adaptive management

While it is stated that the mitigation sites will be monitored in the short-term (usually 5 years), there is no adaptive management plan in place should the wetland mitigation fail or prove to be marginal either in this short term or in a much longer term (15 – 50 years). There are several successful adaptive management plans related to wetland restoration that have been used in wetland mitigation cases, particularly refer to the Delaware Bay Marsh Restoration Project (see Peterson et al., 2005).

References

Altor, A.E. and W.J. Mitsch. 2008. Pulsing hydrology, methane emissions, and carbon dioxide fluxes in created marshes: A 2-year ecosystem study. *Wetlands* 28:423-438.

Anderson, C.J. and W.J. Mitsch. 2008. The influence of flood connectivity on bottomland forest productivity in central Ohio, USA. *Ohio J. Science* 108 (2): 2-8.

Fink, D.F. and W.J. Mitsch. 2007. Hydrology and biogeochemistry in a created river diversion oxbow wetland. *Ecological Engineering* 30:93-102.

Hernandez, M.E. and W.J. Mitsch. 2006. Influence of hydrologic pulses, flooding frequency, and vegetation on nitrous oxide emissions from created riparian marshes. *Wetlands* 26:862-877.

Hernandez, M.E. and W.J. Mitsch. 2007. Denitrification in created riverine wetlands: Influence of hydrology and season. *Ecological Engineering* 30:78-88.

Mitsch, W.J., L. Zhang, C.J. Anderson, A. Altor, and M. Hernandez. 2005. Creating riverine wetlands: Ecological succession, nutrient retention, and pulsing effects. *Ecological Engineering* 25:510-527.

Mitsch, W.J., L. Zhang, D.F. Fink, M.E. Hernandez, A.E. Altor, C.L. Tuttle and A.M. Nahlik. 2008. Ecological engineering of floodplains. *Ecohydrology & Hydrobiology* 8:139-147.

Peterson, S.B., J.M. Teal, and W.J. Mitsch (eds.) 2005. Delaware Bay Salt Marsh Restoration. Special Issue of *Ecological Engineering* 25: 199-314.

Tuttle, C.L., L. Zhang, and W.J. Mitsch. 2008. Aquatic metabolism as an indicator of the ecological effects of hydrologic pulsing in flow-through wetlands. *Ecological Indicators* 8: 795-806.

Significance – High:

With up to 13,000 acres of wetlands lost or affected by the reduced flooding due to this project, the Consolidated NEPA Document does not provide convincing evidence that the loss in wetland function can be mitigated to achieve no net loss of wetlands.

Recommendations for Resolution:

To resolve these concerns, the report would need to be expanded to include:

- Reassess the mitigation plan to include both more detail on the mitigation locations and monitoring and incorporate more wetlands that are open to Mississippi River flooding.
- Determine the loss in function of wetlands that are indirectly affected by the project with the realization that wetlands are distinctly different when flooded by river water as opposed to groundwater and local seepage/runoff.
- Simplify the discussion of wetland mitigation so it is clear how many acres of each wetland type is affected by the project and how many acres of each type of wetland is created, restored, or enhanced as a result of the mitigation.
- Provide an explicit adaptive management plan for wetland mitigation in the report. It should be sequenced to review the mitigation sites at least on an every-other-year cycle after the 5-year monitoring is completed, no matter who is in charge of the sites.
- Provide information about the potential indirect impact of dredging in the St. Johns Bayou on hydrology (function and value) of riparian wetlands.

Comment 6:
The Consolidated NEPA Document is inadequate in justifying the use of the two-year floodplain in calculating the environmental impact.
Basis for Comment:

The Consolidated NEPA Document uses the two-year flood elevation to calculate the extent of the impacts to fish and wildlife. The mean two-year flood elevations are likely to be insensitive to more extreme events that are of importance to species using shallowly flooded areas, and some measure of variance among years that accounts for less frequent events is required to determine the likely impacts overall to these species.

The primary concern for fish is whether two-year flood events provide conditions for needed habitat (spawning, rearing, juvenile, and adult) for fishes and how reduced annual variability in flooding (hydrology) will impact fish populations and fish assemblages. Fish have evolved to natural variation that provides a diversity of environmental conditions ultimately leading to diversity of the fish community as expressed, in part, in the high species richness found in the St. Johns Bayou and New Madrid Floodway. The annual flooding variation not only helps determine available fish habitat but also has a role in the creation, maintenance, and changes in the functional role of the floodplain habitats for fishes. Less frequent flood events can significantly influence year-class strength of a population through increased spawning success and juvenile survival for many species. These flood events, however, have less influence on the long-term population for most species. Flood frequency has a much greater impact on fish communities; reducing flooding that isolates habitat within the floodplain can have localized population influences and thus communities adjust to a different set of environmental characteristics. In this respect, longer and greater flood events do have a beneficial role for fish populations. The model does estimate lost AAHUs on the floodplain that corresponds to the two-year frequency flood. This area of the floodplain receives more frequent and thus less variable annual flooding than the 3-year plus floodplain. Habitat that floods less frequently can have different environmental characteristics than areas that flood more often and this is expressed in differences in the fish assemblage across the floodplain. The Consolidated NEPA Document discusses these expected community changes but does not quantify or address them in mitigation.

As with fish, varying flood frequencies maintain variation in wetland plant communities and diversity. Reducing or controlling these frequencies will likely reduce plant diversity, thus value and function of wetlands within the project area.

While “a regular, recurrent flooding regime of the two-year floodplain”, is not likely to maintain fish community diversity, it is likely to maintain fish base populations; this is not the case for waterfowl and shorebirds. The 2-year floodplain doesn’t consider the loss of habitat for shorebirds and waterfowl due to loss of less frequent flood events. Shorebirds and waterfowl (waterbirds) are very mobile and have adapted to opportunistically exploit resources whenever and wherever they become available, especially during migratory periods. The mobility of waterbirds allows them to survive long fall migrations and survive and actually acquire nutrient reserves for reproduction during spring migration, while migrating over extremely patchy environments. They accomplish this by exploiting these patchy resources to the fullest extent whenever possible during migrations. Thus, for migratory waterbirds, just because a habitat in a

specific region isn't regularly available does not mean it is not critical habitat when it is available. Not all potential wetland habitat is available during migration every year. This is especially true for ephemeral wetlands most often exploited by migratory waterbirds. In fact, annually variable precipitation patters tend to cause surface flooding in one region in one year then in a different region the next. The exploitative nature of migratory waterbirds allows them to utilize these variable habitats even though they may be very unpredictable. Thus, an area does not need to be flooded in a frequent and dependable manner for it to be critically important at supporting migratory waterbirds. Areas that are inundated as infrequently as every 10 to 20 years will likely be exploited and may prove to be critical in supporting the successful migration of waterbird populations by providing habitat during years when little habitat is available at other latitudes. Waterbird habitat will be reduced to some degree on any suitable habitat that no longer floods in any year as a result of the project, and the total amount of suitable habitat that no longer floods must be calculated in order to determine the loss of foraging habitat that would occur post-project. Further justification is needed regarding the use of the two year flooding elevation rather than the total area on which flooding would be reduced as an acceptable approach to calculating loss of habitat for waterbirds and other wildlife. This loss of less frequently inundated habitat needs to be considered when determining mitigation needs for migratory waterbirds.
Significance – High:
The Consolidated NEPA Document underestimates the environmental impact of the loss of greater than 2 year flood events, underestimating necessary mitigation.
Recommendations for Resolution:
To resolve these concerns, the project needs to consider the following: ▪ Conduct an analysis of flood frequency variations, while maintaining a minimum base of habitat. Alternative 3-1.C recognizes the importance of variability. The flood frequency that is most appropriate is best determined through monitoring and adaptive management as the project progresses. The plan should have the flexibility to allow larger flood event (3-10) as a possible alternative if determined necessary to maintain fish and wetland diversity and resources for migratory waterbirds across the floodplain. It should be noted however, that mitigation alternatives proposed actually may reduce flood variation. In the long-term this will change community structure and may reduce diversity on the floodplain. ▪ Include the total area currently subject to flooding in calculations of required mitigation for waterbirds.

Comment 7:
The operation and management costs associated with managed moist soil units and levees around bottomland hardwood flooding were not considered.
Basis for Comment:
The panel was not able to locate a calculation of the substantial ongoing costs for managing the moist soil units intended to provide mitigation for waterfowl and shorebird habitat impacts. In particular, intensively managing an area for waterfowl and shorebird habitat requires annual management of both the water level and the vegetation on the site, including such intensive activities as burning or discing (disturbing the soil with a disc) to control invasive vegetation. Annual costs of managing moist soil units at production levels such as those proposed in this mitigation were approximately \$885/ha in 2006 (Pankau 2008). This equates to a cost of > \$13,000,000 over the 50 year project period, not accounting for inflation. In the panel's opinion, without dedicated funds to support these activities, it is unlikely that ongoing management will persist, and without ongoing management, the high values applied in the shorebird Habitat Evaluation Procedure (HEP) and Duck Usage Days (DUDs) to managed moist soil units will not be achievable. In addition, there does not appear to be an agency specified to take on this significant management responsibility. Carrying out appropriate management for shorebirds and waterfowl will require the efforts of a trained wildlife biologist skilled in moist soil management. These costs do not appear to be calculated as part of the cost assessment, and should be estimated and included in the Consolidated NEPA Document. Furthermore, similar to moist soil units, any levees placed around bottomland hardwood forests will require annual operation and maintenance costs. These costs should also be estimated and included NEPA document. References Pankau, A. K. 2008. Examining cost effectiveness of actively and passively managed wetlands for migrating and wintering waterfowl in Southern Illinois. M.S. Thesis. Southern Illinois University Carbondale.
Significance – High:
Mitigating the impacts of wetland loss is required for this project to proceed, including this information will be critical in ensuring appropriate mitigation and cost benefit analyses are achieved.
Recommendations for Resolution:
To resolve these concerns, the project needs to consider the following: ▪ Provide assurance that appropriate resources (money and expertise) for operation and management of moist soil units and levies around bottomland hardwood forests are available.

Comment 8:
There is strong evidence that moist soil units managed for both shorebirds and waterfowl would not provide habitat at the levels assumed for mitigation of impacts to both shorebirds and waterfowl.
Basis for Comment:
The ability of moist soil units to produce resources for shorebirds and waterfowl at a level presumed under the current Consolidated NEPA Document will require hydrology and vegetation to be managed in a way that maximizes the production of moist soil seeds for waterfowl and the production and availability of aquatic invertebrates for shorebirds. As described below, while managing hydrology and vegetation in a way that provides resources for both waterfowl and shorebirds is possible, such a management approach would dramatically reduce productivity and resource availability for both waterfowl and shorebirds, thus, productivity levels (Duck Usage Days {DUDs} and Habitat Evaluation Procedure {HEP}) for both waterfowl and shorebirds are drastically over estimated in the current mitigation plan. For example, maximizing productivity for waterfowl would require a slow draw down from approximately 1 April to 15 May (Cross and Vohs 1988). This time period coincides nicely with the spring migration of shorebirds, thus, as long as residual vegetation has decomposed adequately, which is often unlikely to be the case, moist soil units could produce both waterfowl and shorebird habitat. The most important limiting factor for shorebirds in the Mississippi Alluvial Valley, however, is fall foraging habitat during southbound migration (Twedt et al. 1998), as documented by the Lower Mississippi Valley Joint Venture management plan for shorebirds in the region (Loesch et al. 2000). Managing moist soil units for the maximum benefit of shorebirds would require fall drawdowns to expose shallowly flooded areas, which virtually eliminates the productivity of moist soil seeds, and thus, DUDs. Additionally, even if it is deemed appropriate to mitigate for shorebird habitat loss with spring migratory habitat, manipulations to control vegetation encroachment has very different effects depending on the season when the activity occurs, and while spring manipulation is optimal for waterfowl, summer manipulation has been shown to be more beneficial for shorebird habitat (Laubhan 1995). Some benefits to waterfowl of moist soil management for shorebirds have been documented in the literature (Laubhan and Fredrickson 1993), including wintering habitat if units are kept flooded at appropriate depths for waterfowl during the winter season. There are important limitations, however, to the use of managed lands for both shorebirds and waterfowl. Currently all shorebird mitigation and the majority of waterfowl mitigation is based on the successful management of moist soil units. References Cross, D., and P. Vohs, (eds). 1988. Waterfowl Management Handbook. Fort Collins, CO: U.S. Fish and Wildlife Service. Laubhan, M.K., and L.H. Fredrickson. 1993. Integrated Wetland Management: Concepts and Opportunities. Special Session 6 of Wetland Management for Shorebirds and Other Species. *In* G.H. Finney and G. Castro. (eds.) *Transactions of the 58th North American Wildlife and Natural Resources Conferences,* Wildlife Management Institute. Laubhan, M. K. 1995. Effects of prescribed fire on moist-soil vegetation and soil macronutrients.

Wetlands 15:159-166.

Loesch, C.R., D. J. T., K. Tripp, W.C. Hunter, and M.S. Woodrey. 2000. Development of Management Objectives for Waterfowl and Shorebirds in the Mississippi Alluvial Valley, Pages 8-11. *In* D. P. R. Bonney, R.J. Cooper and L. Niles, (eds.), Strategies for Bird Conservation: The Partners in Flight Planning Process, *Proceedings of the 3rd Partners in Flight Workshop*, 1995 October 1-5, Cape May, NJ. U.S. Department of Agriculture, Forest Service, Rocky Mountain Experiment Station, Ogden UT.

Twedt, D. J., C. O. Nelms, V. E. Rettig, and S. R. Aycock. 1998. Shorebird Use of Managed Wetlands in the Mississippi Alluvial Valley. *The American Midland Naturalist* 140:140-152.

Loesch, C.R., D. J. T., K. Tripp, W.C. Hunter, and M.S. Woodrey. 2000. Development of Management Objectives for Waterfowl and Shorebirds in the Mississippi Alluvial Valley, Pages 8-11. *In* D. P. R. Bonney, R.J. Cooper and L. Niles, (eds.), Strategies for Bird Conservation: The Partners in Flight Planning Process, *Proceedings of the 3rd Partners in Flight Workshop*, 1995 October 1-5, Cape May, NJ. U.S. Department of Agriculture, Forest Service, Rocky Mountain Experiment Station, Ogden UT.

Twedt, D. J., C. O. Nelms, V. E. Rettig, and S. R. Aycock. 1998. Shorebird Use of Managed Wetlands in the Mississippi Alluvial Valley. *The American Midland Naturalist* 140:140-152.

Significance – High:

Estimates of current benefits of moist soil units for proposed mitigation are based on values achieved when habitat is either managed specifically for shorebirds or specifically for waterfowl. These benefits are thus over estimates when habitat is to be managed simultaneously for both.

Recommendations for Resolution:

To resolve these concerns, project needs to consider the following:

- Decrease the value of moist soil units for both shorebirds and waterfowl based on more recent values from studies on wetlands being managed for multi uses and either (a) recalculate the acreage needed for mitigation or (b) provide moist soil waterfowl and shorebirds separately.

Comment 9:
Mitigating floodplain average annual habitat unit (AAHU) loss with modified borrow pits overestimates compensation of mid-season fish rearing habitat.
Basis for Comment:
Modified barrow pits as described for the St. Johns Bayou can provide habitat for fishes. Modifications in shape, size, depth (greater amounts of shallow areas), and bottom contour will increase habitat heterogeneity for fishes and improve the quality of the habitat. The fish model as applied calculates maximum value for fish rearing habitat for the 5 mid-season rearing evaluation species used in the model. These maximum values are a result of a higher Habitat Suitability Index (HSI) for oxbow lakes than other habitats and the fact that each acre of the lake receives 100% weighted value in the calculation of Average Daily Flooded Acres (ADFAs). The ecological function of oxbow lakes and fish community composition are influenced by lake characteristics, surrounding riparian habitat in the floodplain, and connectivity to the river. These details should to be considered in the design of modified barrow pits to provide the highest possible habitat quality (max HSI score for this habitat). The panel did not see any information that indicates the Habitat Evaluation Procedure (HEP) team approved HSI values assigned to oxbow lakes be used for borrow pits or that borrow pits were considered in HSI valuation. In the panel's opinion, not all borrow pit acres are suitable rearing habitat for the 5 evaluation species. This assumption leads to an over representation of the value of the compensation acres. For example, pirate perch is a shallow water floodplain lake species associated with abundant cover in the littoral zone. Much of the borrow pit acreage does not fit this description and will be of less value for this species. Therefore, the HSI score as applied to calculate the AAHUs is too high. A final consideration is that no transition period was applied to borrow pit habitat. Since its function is dependent, in part, on the surrounding riparian area (bottomland hardwoods with a 10 to 20 year transition) that should seasonally flood and connect to the borrow pits a transition period is warranted.
Significance – High:
The Consolidated NEPA Document overestimates the value of modified borrow pit acres used for mitigation of mid-season fish rearing habitat, thereby under compensating for lost AAHUs.
Recommendations for Resolution:
To resolve these concerns, the project needs to consider the following: ▪ Determine and apply specific discount criteria to the HSI value for borrow pit mid-season rearing habitat. This could include river connectivity (time and duration), location within the floodway, surrounding riparian habitat, lake morphometrics, and water quality. ▪ Determine acreage of mid-season rearing habitat as a subset of water surface area of borrow pits and apply to determination of ADFAs and AAHUs. ▪ Incorporate a transition period for the establishment of functional bottomland hardwoods into the calculation of AAHUs for borrow pit habitat.

Comment 10:
Additional reforestation opportunities should be considered to fully compensate for mid-season fish-rearing habitat in the St. Johns Bayou and New Madrid Floodway since the floodway was historically a bottomland hardwood ecosystem.
Basis for Comment:
Project impacts on mid-season fish rearing habitat are estimated to be 1,884 and 2,329 Average Annual Habitat Units (AAHUs) in the St. Johns Bayou and New Madrid Floodway, respectively. The Basic Mitigation Feature estimates 1,884 AAHUs (313 with reforestation and 1,571 with barrow pits) and 51 AAHUs (38 with reforestation, 9 with vegetated buffers, and 4 with wildlife corridor easement) in the Bayou and Floodway, respectively. The Basic Mitigation Feature (Basic Feature) for the New Madrid Floodway provides only 2% of the mid-season fish rearing habitat AAHUs needed for mitigation. Although additional techniques that supplement the Basic Feature are proposed, they depend too much on non-reforestation. Reforestation should be the primary technique used since the Bayou/floodway was historically a bottomland hardwood ecosystem and the dominant habitat type. However, within the bottomland hardwood floodplain other important fish habitats exist that include permanent floodplain lakes, ephemeral floodplain pools, sloughs, and bayous that are all seasonally connected to the Mississippi River. This habitat diversity and the connection to the Mississippi River provide the foundation for the fish species richness and diversity found in the floodways. Therefore, a diversity of habitat mitigation techniques should be the goal of the Basic Mitigation Feature.
Significance – High:
Mitigation techniques that gain AAHUs by focusing on limited types of floodplain habitats (primarily permanent water bodies) and not reforestation may reduce species richness and diversity in the floodways.
Recommendations for Resolution:
To resolve these concerns, the project needs to consider the following: ▪ Revise the Basic Mitigation Feature to include a much greater percentage of the AAHUs through reforestation. ▪ Ensure the mitigation team agrees on the appropriate AHHU amounts provided by each of the main habitat types in the Basic Mitigation Feature and in the Additional Techniques that supplement the Basic Feature. The panel suggests that no single mitigation approach dominate as currently proposed.

Comment 11:
The Consolidated NEPA Document does not appear to compensate for the amount of shorebird habitat impacted, and does not provide sufficient detail to determine if mitigation of shorebird impacts can be achieved.
Basis for Comment:
The mitigation plan for shorebird habitat impacts cannot be adequately evaluated from the information provided in the Consolidated NEPA Document. The Consolidated NEPA Document itself, and the information provided in Appendix L relative to shorebird habitats, provide only the results of the calculations on Average Annual Habitat Units (AAHUs) lost due to the project, but provide no information about how the calculations were made. The supporting materials provided in the Revised New Madrid Floodway Terrestrial Habitat Evaluation Procedures dated September 4, 2001, also provide only the acreage inputs and the final amount of mitigation acres proposed, with no indication of how the results were calculated. Without this information, it is impossible to determine if the mitigation plan is adequate. The input values for suitable habitats are dramatically larger than the resulting values for impacted areas. For example, Table 4 in the Revised New Madrid Floodway Terrestrial Habitat Evaluation Procedures dated September 4, 2001, lists inputs of 1,632.6 acres of existing cropland in the New Madrid Floodway within 1 foot of the 50% exceedence level, and 36,968.3 acres greater than 1 foot above the same level, but Table 5 provides a result of only 605.53 AAHU's lost under Alternative 3, with no information about how the calculation was completed. Because no detail was provided about what calculations were actually conducted, it is impossible to determine how the total acreage needed to mitigate for shorebird impacts was determined. However, the total acreage appears to be substantially lower than what would be expected from the large reductions in flooding on suitable shorebird habitat under current conditions that would result from implementation of the project. The project aims to reduce seasonal flooding during the shorebird migration season over very large areas of cropland. All shallowly flooded and sparsely vegetated areas that are subsequently exposed during the shorebird migration period will provide suitable shorebird habitat. The panel believes it is likely that the impacted acreage of shorebird habitat is much greater than the estimates provided in the report. In addition, the Consolidated NEPA Document does not adequately justify the projected post-project increase in rice acreage. The Consolidated NEPA Document states on page 125 that "At the time the shorebird model was developed, the HEP team assumed that cropping patterns under future with-project conditions would include increased rice acreage. That assumption accounts for most of the shorebird habitat value under both project alternatives." It is not clear why the assumption was made that the project would result in an increase in rice acreage, and this assumption is critical to determining likely project impacts. An explicit mitigation plan is needed to address impacts if this assumption of increased rice acreage turns out to be incorrect. In addition, some literature suggests that shorebirds use other agricultural field types more extensively when they are flooded, including soybeans (Twedt et al. 1998), so the assumption that rice acreage would be the most valuable requires further justification. The Consolidated NEPA Document also incorrectly states that spring migration habitat for shorebirds are the most critical timeframe: "The shorebird HEP addresses only spring migration habitat, since that timeframe was considered most critical throughout the year" (page 124).

Spring migration habitat is not the most critical habitat for shorebirds in this region, where shorebird species are most likely to be limited by fall migration habitat (Loesch et al. 2000; Skagen 2006). References Loesch, C.R., D. J. T., K. Tripp, W.C. Hunter, and M.S. Woodrey. 2000. Development of Management Objectives for Waterfowl and Shorebirds in the Mississippi Alluvial Valley, Pages 8-11. *In* D. P. R. Bonney, R.J. Cooper and L. Niles, (eds.), Strategies for Bird Conservation: The Partners in Flight Planning Process, *Proceedings of the 3rd Partners in Flight Workshop*, 1995 October 1-5, Cape May, NJ. U.S. Department of Agriculture, Forest Service, Rocky Mountain Experiment Station, Ogden UT. Skagen, S. K., D. A. Granfors, and C. P. Melcher. 2008. On Determining the Significance of Ephemeral Continental Wetlands to North American Migratory Shorebirds. *The Auk* 125:20-29. Twedt, D. J., C. O. Nelms, V. E. Rettig, and S. R. Aycock. 1998. Shorebird Use of Managed Wetlands in the Mississippi Alluvial Valley. The American Midland Naturalist 140:140-152
Significance – High:
An accurate and fully documented assessment of impacts to shorebird habitats is essential to avoiding and minimizing adverse consequences, and developing an adequate compensatory mitigation plan.
Recommendations for Resolution:
To resolve these concerns, the project needs to consider the following: ▪ Calculate the amount of shorebird habitat to be impacted, describing in detail the application of the HEP model and the assumptions made about the extent of shallowly flooded area in each project year; ▪ Develop a mitigation plan that demonstrably replaces the total amount of shallowly flooded and subsequently exposed habitat that currently occurs under existing conditions in the project area.

Comment 12:

It is unclear if a combination of flooding and soil maps were used to determine the extent of existing jurisdictional wetlands and what wetland delineation methodology was used.

Basis for Comment:

The National Resource Conservation Service (NRCS) classified only 520 acres in the project area as farmed jurisdictional wetlands on the total project area while the USACE determined that backwater flooding would be reduced on 1,296 and 5,417 acres (total = 6,713) of agricultural lands in the St. Johns Bayou and New Madrid Floodway, respectively.

Wetland delineation to determine the extent of jurisdictional wetlands usually requires independent identification of water, soils, and vegetation. In this case, floodwater mapping was used with some ground truthing by the USACE while the NRCS depended primarily on the USDA hydric soils maps and color slides from 1984-89 for summer conditions, not spring.

The panel agrees with the Consolidated NEPA Document that the methodology described by the USACE is more defensible. At a minimum, the USACE figure should be used. However, it is not clear how much total area currently meets the hydrological criteria for wetlands. This is important because the project will result in less river flooding on additional agricultural habitat, and these acres may or may not fall within the criteria of jurisdictional wetlands, but they do provide habitat that is used by spring migratory waterfowl and shorebirds. Thus, the project will lead to a decrease in the function of those habitats as well as those in the jurisdictional wetlands category. The panel would like to know if there was any attempt to determine if all the areas designated as hydric soils by the USDA on this site were included in the wetland areas identified by the USACE in this report.

Finally, it is not clear what methodology the NRCS used to calculate the amount of acres that would experience reduced inundation in Appendix D, Table 2, and how this relates to their methodology for measuring farmed wetlands. The methodology that resulted in the NRCS numbers in Table 2 of Appendix D should be more fully explained, and the reasons for the differences between the NRCS and USACE calculations should be explained.

The panel also believes that the calculations for wetland area lost, both agricultural and natural are difficult to interpret, both in the report and in Appendix D.

Significance –High:

Accurately determining jurisdictional wetlands is critical to measuring the impacts of the project, and to the design of appropriate mitigation for project impacts.

Recommendations for Resolution:

To resolve these concerns, the projects need to be expanded to include the following:

- Describe the extent to which soils and soil maps were used to validate the estimated jurisdictional wetlands determined primarily by hydrology by USACE.
- Use scientific names for dominant trees and other vegetation and an indication of their wetland classification (OBL, FACW etc.).
- Provide a clear, succinct, and quantitative tabulation and ecological description of the jurisdictional wetlands lost or impacted due to the entire project.

Comment 13:
Reclassification of habitat to permanent waterbody based upon 100% flooding during the mid-season fish rearing period inappropriately increases the cumulative habitat suitability index (HSI).
Basis for Comment:
The basic mitigation feature for the New Madrid Floodway provides only 52 of the impacted 2,329 Average Annual Habitat Units AAHUs. The vast majority of the remaining AAHUs are mitigated through four possible alternative scenarios that depend primarily on reclassification of habitat to permanent waterbody through modified gate operations (Table 5.26). Increasing flood duration during the 45 day mid-season fish rearing period would increase the Average Daily Flooded Acres ADFAs proportionately up to 100%. However, the reclassification of habitat to permanent water that increases the cumulative Habitat Suitability Index (HSI) value is inappropriate with this duration of flooding. Characteristics that define aquatic habitat as permanent waterbody are not restricted to fish spawning and rearing periods, but are based, in part, on year-round water. This is supported by the original land-use classification/quantification in the floodways using GIS (5.6.1.1 pages 145-147) and in the seven classification criteria listed for permanent waterbodies found in the Consolidated NEPA Document as shown below (5.6.15.25 pages 175-178). 1. Waterbodies form or are replenished during rising water levels but retain water on the floodplain after floods recede as river stages fall. 2. Portions of the waterbodies remain sufficiently deep to retain significant volumes of water for a prolonged period. 3. Reduced occurrence of water level fluctuations so that stranding of eggs and displacement of larvae are less likely. 4. Warmer water temperatures that result in higher primary productivity (biomass produced per unit area) than the river (due to isolation and shallow littoral zone) thus providing an abundant food supply (phytoplankton and zooplankton) for fishes. 5. Periodic connection to the mainstem river either prior to or during the rearing period to provide access by spawning adults. 6. Depositional material forming the nutrient rich substrate that leads to higher chlorophyll content and rapid biochemical cycling. 7. Structural diversity of the littoral zone. Modified criteria (also provided in the Consolidated NEPA Document) that reclassifies habitat to permanent water by retaining water during 100% of the mid-season rearing period (only 12% of the year) fails to meet the above classification criteria (5.6.15.25 pages 175-178). In addition, reclassification was proposed without specific guidance or criteria for water temperature and other water quality considerations, productivity, structural diversity of littoral zones, reduced water level fluctuations, depth, and river connectivity (all in the original permanent waterbody criteria listed above).
Significance – High:
Nearly all (1,309 to 2,505 AAHUs; Table 5.26) of the fish mitigation in the New Madrid Floodway is based on increased cumulative HSI values due to reclassification of habitat to permanent water. However, habitat criteria (listed above) were not met and reclassification was

only based on increased flooding during the mid-season rearing period.
Recommendations for Resolution:
To resolve these concerns, the project needs to consider the following: ▪ Ensure the HEP and Mitigation Teams develops specific criteria that would allow habitat reclassification to permanent waterbody. This should be based on the assumption that this habitat is available all year and not just during the mid-season fish spawning period. Reclassification consideration should be based, in part, on all seven criteria listed above. ▪ If criteria for reclassification are not met, then holding water back and flooding during the mid-season rearing period should only increase ADFAs up to 100% and not result in a change in HSI due to habitat reclassification to permanent water.

Comment 14:
The proposed monitoring plans for fish passage, spawning, and rearing utilization lack critical study design and time-frame details.
Basis for Comment:
Fish passage into and out of the floodways from the Mississippi River is a primary assumption in the fish model (5.6.14.4 pages 162-163) and has not been tested. In the Consolidated NEPA Document, proposed monitoring is based solely on a mark/recapture study. The panel believes that other methods and approaches should be considered to monitor fish passage including hydroacoustics, telemetry, directional trapping, pre- and post project evaluations, and St Johns Bayou and New Madrid Floodway comparisons. Relations of passage to the time of year, water temperature, river stage, fish species, life history stage and other environmental characteristics that may influence passage should also be evaluated as part of this new study. This project can provide an opportunity to gain much needed information on fish passage through culverts for a large river ecosystem and is needed to support the assumption that fish passage occurs and is not impacted by gate operations. However, the details of monitoring are missing from the Consolidated NEPA Document. A second feature of proposed monitoring was assessment of spawning and rearing utilization of mitigation tracts. Mitigation for this project depends on improved habitat for fishes. Mitigation features of the plan include raising mid-season rearing habitat HSI values by changing habitat types (agriculture to bottomland hardwood or permanent water), and increased inundation time during the mid-season period (up to 100%) that increases ADFAs (5.6.15.2 pages 170-180). However, the mitigation plan does not discuss detailed monitoring of these changes as they pertain to fish spawning or rearing. Monitoring is critical for mitigation evaluation and the adaptive management proposed in the Consolidated NEPA Document.
Significance – High:
An evaluation/comparison of current fish passage between the Mississippi River and SJB/NMF for the pre- and post- construction conditions is critical. In addition, monitoring spawning and rearing habitats is critical to proposed fish mitigation.
Recommendations for Resolution:
To resolve these concerns, the project needs to consider the following: ▪ Evaluate fish movement into and out of the floodways, both prior to and after project construction. ▪ Monitor spawning success and juvenile fishes to determine if access changes and mitigation of floodplain habitats influenced fish populations pre- and post project construction. These studies can also be used to evaluate increased changes in HSI values assigned to different habitats and the transition times associated with habitat changes.

Comment 15:
The accuracy of the hydrologic and hydraulic analyses needs to be improved by extending the period-of-analysis and using more detailed modeling techniques.
Basis for Comment:
Changes in the results of the hydrologic and hydraulic analyses can directly affect the economic feasibility of the project as well as formulation of environmental mitigation plans, especially where the benefit-to-cost ratio is near one. Economic and environmental assessments are based on hydrologic and hydraulic analyses. The economic benefit-to-cost ratio for the proposed plan is slightly above one. The benefit-to-cost ratio is below one for many of the alternatives considered. The marginal economic feasibility of the project means that the accuracy of the hydrologic and hydraulic analyses upon which the economic evaluations are based is particularly important. A 32-year 1943-1974 hydrologic period-of-analysis was adopted for the Consolidated NEPA Document. The accuracy and credibility of the hydrologic analyses presented in Appendix C as well as various other environmental and economic studies that utilize the results of these hydrologic analyses would be improved by changing to a 67-year 1943-2009 period-of-analysis. Gauged rainfall and stream flow data for 1975-2009 are likely available at most of the sites having data for 1943-1974. Staying with the 1943-1974 period-of-analysis has the advantages of allowing studies completed years ago to continue to be used and allowing consistency in comparing studies performed over the past number of years. Updating to 1943-2009 would require redoing a significant amount of work and would affect various aspects of the overall study. However, updating the hydrologic period-of-analysis in future studies would improve the accuracy and credibility of the analyses and thus probably would be worth the effort. The accuracy of the water surface profiles for flows in the channels could also be improved with more in depth hydraulic modeling techniques. With the very flat floodplains, a small change in flood stage will translate to a relatively large change in land area inundated. Channel stages discussed in Appendix C of the Consolidated NEPA Document were estimated based on the Manning equation assuming uniform flow, which does not properly capture backwater effects. The USACE Hydrologic Engineering Center (HEC) River Analysis System (RAS) computer model facilitates developing water surface profiles based on gradually varied flow energy equation computations or even unsteady flow dynamic routing. Improvements in accuracy of stage estimates that are possible using HEC-RAS will probably justify the additional effort. The hydrologic simulation study presented in Appendix C was performed using the HUXRAIN model developed by the USACE Memphis District. The model uses a daily time step and 1943-1974 simulation period. The continuous watershed (rainfall-runoff) modeling component of HUXRAIN computes daily flows for inputted daily rainfall from the several rain gages located in the basins using API methodology. More recently developed watershed models such as the USDA Agricultural Research Service (ARS) Soil and Water Assessment Tool (SWAT) and the latest expanded version of the UASCE Hydrologic Engineering Center Hydrologic Modeling System (HEC-HMS) probably provide more detailed rainfall-runoff modeling capabilities. However, HUXRAIN also provides hydraulic analysis capabilities for simulating the levee sump operations. The HUXRAIN simulations generated 1943-1974 sequences of daily water surface

elevations in the sump areas for existing conditions, the authorized project, and proposed alternatives to the authorized project which are presented in Appendix C of the Consolidated NEPA Document. If the simulations are updated from the 1943-1974 period-of-analysis to 1943-2009, a comparative assessment of currently available alternative generalized hydrologic simulation models could also be made along with the input data update to decide whether to continue to apply HUXRAIN or switch to another model such as SWAT or HEC-HMS.
Significance – High:
The significance is classified as high because changes in the results of the hydrology and hydraulics studies can directly impact the economic feasibility of the project as well as environmental assessments and plan formulation. Improvements in the accuracy of the hydrologic and hydraulic analysis could significantly affect the final recommendations.
Recommendations for Resolution:
To resolve these concerns, the project needs to consider the following: ▪ Extend the hydrologic period-of-analysis from 1943-1974 to 1943-2009. This would require a new hydrologic and hydraulic analysis be conducted as well as revisions to the economic and environmental analyses that build upon the hydrology and hydraulics information. ▪ Re-compute water surface profiles for the channels should using HEC-RAS assuming either steady gradually varied flow or unsteady flow rather than applying the Manning equation assuming uniform flow. ▪ Revaluate the HUXRAIN simulation studies to determine whether other enhancements to the methodologies adopted for the watershed modeling and hydraulic modeling of facility operations are warranted.

Comment 16:
Impacts to shorebird habitats cannot be determined based on the information provided in the Consolidated NEPA Document, but the impacts are probably much larger than the analysis indicates.
Basis for Comment:
The Consolidated NEPA Document does not include sufficient detail to determine the methodology used or the accuracy of the resulting estimate of impacts to shorebirds. The supporting document referenced in the Consolidated NEPA Document, The Habitat Evaluation Procedure (HEP) model presented in the Revised New Madrid Floodway Terrestrial Habitat Evaluation Procedures dated September 4, 2001, describes some aspects of the analysis used. However, the application of the model appears to be seriously flawed and cannot be evaluated with the information provided, so the impacts to shorebird habitats cannot be determined. There are two important but related issues to address: The total amount of currently existing shallowly flooded and sparsely vegetated habitat appears to be substantially larger than the amount of habitat loss to be mitigated, but the extent of the impacts cannot be determined from the Consolidated NEPA Document or the supporting documents. For shorebirds, the amount of habitat that occurs in each season includes all areas of sparsely vegetated habitat that are shallowly flooded or exposed as flooding recedes, and the total area available will depend on the maximum extent of flooding in each year. When calculating inundation under current conditions, the panel believes that USACE used a median value for flooding levels, and based shorebird habitat calculations on conditions during the 2-year flood (Tables 5.2 and 5.3, pages 94-5). The text accompanying Tables 5.2 and 5.3 of the Final Consolidated NEPA Document (pages 93-95) indicates that the project would “reduce flooding on 44,545 acres” in St. Johns Bayou, and “on up to 61,800 acres” in the New Madrid Floodway, but only by 2,717 acres and 10,319 acres respectively for the mean two year flood event. The larger figures are presumably measured for less frequent flooding events such as the 30-year flood (although Table S.1 provides different numbers for maximum acreage not flooded under the 30-year flood with post-project conditions, of 55,000 acres in St. Johns Bayou, and 75,078 in the New Madrid Floodway, Page iv). There is a large difference between the calculations of impacted shorebird habitat and acreage with reduced flooding, and any reduction in flooding of suitable habitat would be expected to have some impact on potential use of the area by shorebirds. Using the mean two-year flood frequency, without accounting for the much larger impacts that occur less frequently, will not adequately assess the impacts to shorebird habitat as a result of the project. The application of the HEP model cannot be evaluated from the information provided, but it is the panel’s opinion that it substantially underestimates the amount of shorebird habitat by using static water levels for each month. The Revised New Madrid Floodway Terrestrial Habitat Evaluation Procedure dated September 4, 2001 does not provide enough detail to determine how the results in Table 5 showing total shorebird AAHU’s were calculated. The result of approximately 600 AAHU’s for Alternative 3 suggests that the calculations of impacted habitat included approximately 1200 acres, given the HSI value of 0.5 for low elevation croplands.

The panel believes that the amount of currently available shorebird habitat has been calculated from the three static flood elevations for March, April, and May, as given in Table 2 of the Revised New Madrid Floodway Terrestrial Habitat Evaluation Procedures dated September 4, 2001 (Habitat Evaluation Procedures), rather than by estimating the total area first flooded and then exposed at some point during the entire migration period. The metric of importance for shorebird habitat is the total amount of area that will no longer be flooded and then exposed under post-project conditions in each year during which the project is operational. This includes all sparsely vegetated areas that are first flooded and then exposed as flood waters recede, since shorebirds can opportunistically respond to newly exposed habitat, virtually wherever it occurs on their migration route (Helmers 1992; Lehnen and Krementz 2005), and since wetter seasons with more ephemeral flooding have been shown to provide greater weight gain for foraging shorebirds during migration (Farmer and Weins 1999).

Table 2 of the Habitat Evaluation Procedures provides one single elevation during each month for water levels used to determine the amounts of acreage suitable for shorebird habitat. It is the panel's understanding that the GIS analysis used these static water levels to calculate the amount of area within 1 foot of this elevation, and the resulting areas were then used as input for the habitat model. However, the panel believes that the report significantly underestimates the total number of acres of suitable habitat that would be available to shorebirds during the course of each migration season. During each of these months, water levels will be changing over time and either flooding or receding and exposing different areas. Shorebirds can use any shallowly flooded or recently exposed area for foraging, so the input values appear to significantly underestimate the total number of acres of suitable habitat that would be available to shorebirds during the course of each migration season. In addition to the likely underestimate described above under point 1, using static water levels will also likely significantly underestimate the amount of area actually available to shorebirds under current conditions.

One additional detail is also important in assessing the application of the HEP model. The HEP model references Hands (1991) as the basis for assuming that flooded agricultural fields will have approximately 0.1 times the value of managed moist soil units, but it is unclear what values were actually used in the analysis. Figure 1 (Habitat Evaluation Procedures) indicates a value of 0.5 for low elevation cropland, and 0.1 for high elevation cropland. However, the agricultural areas described in Hands (1991) are drainage ditches with shallow margins exposed by drawdowns, not open agricultural fields (p. 458). The relative value of agricultural fields is probably better represented by data from Twedt et al. (1998), which reports that previously dry and then flooded agricultural land has approximately 0.5 times the density of shorebirds found on managed moist soil units with a gradual drawdown. The HEP model should be corrected to use 0.5 rather than 0.1 as an approximate HSI value for all shallowly flooded and gradually exposed croplands, and the calculations used to apply the model should be clearly described, accounting for all cropland that is shallowly flooded and then exposed during the migration window.

References

Farmer, A. H. and J. A. Wiens. 1999. Models and reality: Time-energy trade-offs in Pectoral Sandpiper (Calidris melanotos) migration. *Ecology* 80:2566-2580.

Hands, H.M., M. R. Ryan, and J.W. Smith. 1991. Migrant shorebird use of marsh, moist-soil, and flooded agricultural habitats. *Wildlife Society Bulletin* 19:457-464.

Helmers, D. 1992. Shorebird Management Manual. Western Hemisphere Shorebird Reserve Network Manomet, MA. 58p.

Lehnen, S. E., and D. G. Krementz. 2005. Turnover Rates of Fall-Migrating Pectoral Sandpipers in the Lower Mississippi Alluvial Valley. *Journal of Wildlife Management* 69:671-680.

Twedt, D. J., C. O. Nelms, V. E. Rettig, and S. R. Aycock. 1998. Shorebird Use of Managed Wetlands in the Mississippi Alluvial Valley. *The American Midland Naturalist* 140:140-152.

Significance – High:

The Consolidated NEPA Document underestimates the impacts to shorebird habitats, and therefore underestimates the amount of mitigation necessary to compensate for those impacts.

Recommendations for Resolution:

To resolve these concerns, the project needs to consider the following:

- Conduct a detailed GIS analysis of the amount of shallowly flooded sparsely vegetated habitat, such as cropped fields or herbaceous areas that would be reduced in each year by implementation of the project.
- Ensure the detailed GIS analysis includes a measure of the impacts expected from less frequent but large scale flooding events, and the total area that would be first flooded and then gradually exposed during the shorebird migration period, and should also account for gradual lowering of flood elevations that exposes new habitat areas as flooding recedes during each migration season.

Comment 17:
It is unclear if fish from the Mississippi River will have access to the St. Johns Bayou and New Madrid Floodway based solely on water stages, gate operations, and current fish species composition of the St. Johns Bayou.
Basis for Comment:
The information presented in the Consolidated NEPA Document supports the assumption that riverine fish species exist in the St. Johns Bayou. However, fish access studies through the St. Johns Bayou culverts were not cited. It is unclear if fish from the Mississippi River pass through the existing St. Johns Bayou culverts as operated or if access is restricted in any way. In addition, species, timing, water temperature, and river stage of floodplain access are unknown for both the St. Johns Bayou and the New Madrid Floodway. Once current access is quantified (restricted in the St. Johns Bayou and open in the New Madrid Floodway) fish project impacts can be assessed. In addition, proposed operating rule curves can be developed and evaluated based on fish access during critical life-history periods. If access is restricted and spawning and rearing success impacted the fish model mitigation should be modified to account for the impact.
Significance – High:
The assumption of fish access through the culverts of the St. Johns Bayou has not been tested and is based solely on floodway species lists. Gate operating rule curves and fish impacts cannot be fully assessed until additional information is collected.
Recommendations for Resolution:
To resolve these concerns, the project needs to consider the following: ▪ Support the indirect evidence by quantification of Pre- construction fish access in the St. Johns Bayou (culvert/gate operation access) and compared to open access in the New Madrid Floodway. ▪ Conduct post construction access studies to evaluate impacts including monitoring by mark/recapture, hydroacoustics, telemetry, and directional trapping. Evaluate the relationship of fish passage to the time of year, temperature, river stage, fish species, life history stage, and other environmental characteristics. ▪ Potential modifications to operating rule curves may be warranted based on results from fish passage monitoring studies.

Comment 18:
Use of mid-season rearing habitat for mitigation is not fully justified and is only represented by 3 (New Madrid Floodway) to 5 (St Johns Bayou) evaluation species in the Habitat Suitability Index (HSI) model.
Basis for Comment:
In the Consolidated NEPA Document, mid-season rearing habitat is defined based on flooded acres with no depth requirement, discounted proportionately to flooding over a 45 day period from May 1 through April 15. This method assesses mitigation acreage needed based on the amount of time during the mid-season rearing period when water is present. Spawning habitat is defined as acres flooded at least 1 foot deep for 8 consecutive days. By definition, all spawning habitat is considered rearing habitat. The decision to use mid-season rearing habitat for mitigation appears to be based on the highest measure of impacts (acreage). The Consolidated NEPA Document suggests that mid-season rearing may not be the most biologically justified life history period for mitigation with the statement "The Corps maintains spawning is the most appropriate habitat impact to measure" (5.6.1.1 pages 145-147). In addition, while the panel believes that the early and late season spawning/rearing habitat is the most important time period for some species, a complete evaluation of how many and which species in the floodway/Bayou fall into each of the rearing/spawning time periods was not provided. If impacts and mitigation are based only on mid-season rearing, then these fish must rely on carryover compensation. Early and late season rearing and spawning habitat, mid-season spawning habitat, and adult habitat loss has either not been quantified or compensated in the mitigation. To fully understand and determine the best mitigation approach an evaluation should be conducted that compares impacts and mitigation for all life history stages and time periods since evaluation species utilize all rearing periods (2 early-season, 5 mid-season, and 4 late-season). Species were assigned a spawning guild (13 types possible with representative species in both Floodways that cover 11 spawning types) and rearing habitat (2 types: floodplain or channel). Six of the 11 spawning guilds were represented by evaluation species. Eight evaluation species were classified rearing in the floodplain and 4 evaluation species were classified rearing in channel habitat. The 12 evaluation species were said to represent over 91% of the species in the project area. The panel can only assume which species of fish were represented by the spawning guild and rearing habitat combinations that included over 91% of the species in the project area as this was not described specifically in the Consolidated NEPA Document. It would be of more interest to know the percentage of species represented for each floodways independently since the floodways do not contain the same species. In the final analysis, only 5 and 3 evaluation species are used in the calculation of cumulative (Habitat Suitability Indexes) HSIs for mid-season rearing habitats in St. Johns Bayou and New Madrid Floodway. The other species either used another time period for spawning and rearing and/or were not collected in a Floodway. This number represents a much smaller percentage of species in the combinations of spawning guilds and rearing habitats.

Significance – High:
Fish impacts and mitigation is based on a single life history period (mid-season rearing) and on a small number of evaluation species, resulting in an incomplete evaluation of project impacts and mitigation needs.
Recommendations for Resolution:
To resolve these concerns, the project needs to consider the following: ▪ Determine impacts (annual daily flooded acres (ADFAs) and cumulative habitat units (HUs) for each life history stage/habitat as part of the evaluation process and evaluate the impacts of only mitigating a single life history stage/time period on the fish community (especially on those species that use other habitat or time periods that are impacted but not mitigated) ▪ Evaluate expected fish species use of each rearing/spawning period and habitat prior to selecting life history stage(s)/time period(s) for measuring impacts and mitigation. ▪ Represent the HSI model with a larger number of species and multiple species for each guild designation. This is especially true for the selected life history stage(s)/time period(s) selected to measure impacts and mitigation.

Comment 19:
The four mitigation alternatives presented in the Consolidated NEPA Document do not appear to compensate for loss of waterfowl habitat.
Basis for Comment:

The panel believes that estimating mitigation needs for waterfowl based on Duck Usage Days (DUDs) is the appropriate approach. For the following reasons we do not believe that the loss of waterfowl habitat will be mitigated appropriately under any of the 4 mitigation alternatives.

(i) Dabbling duck populations are driven primarily by factors that influence productivity. Thus, duck populations are much more likely to be influenced by spring migratory habitat, a period when ducks are acquiring nutrient reserves for egg production and incubation, than wintering habitat. Mitigation emphasis, therefore, should be on mitigating spring migratory habitat to ensure impacts to duck populations are minimized. Only secondary consideration should be given to providing winter habitat for maintaining the recreational value and economic benefits (duck sport hunting) in this region. Because providing wintering habitat (DUDs) beyond those that were available prior to the implementation of this project will not influence the ability of dabbling ducks to acquire nutrient reserves for reproduction, overcompensating loss of DUDs during the wintering period does not adequately mitigate lost DUDs for ducks during spring.

(ii) After a brief review of the WHAM model used to estimate mitigation requirements in the Consolidated NEPA Document, it appears values of energetic carrying capacity are outdated and not appropriate for modeling DUDs for spring migratory habitat. Furthermore, in addition to having greater energetic costs, unlike winter, spring migratory ducks are acquiring endogenous nutrient reserves, thus, the energetic demand of ducks is much greater in spring than winter, which are the values used in the model.

(iii) Although there is detailed reference to reforestation to mitigate waterfowl habitat loss, there is little detail on how, when, and to what level these forested tracts will be flooded. Reforestation will only mitigate waterfowl habitat loss if forested habitat is inundated with standing water at or below a level of 30 cm during the spring migration.

(iv) It is highly unlikely that the moist soil units will be able to meet the productivity levels indicated if they are operated to provide both waterfowl and shorebird habitat. Shorebirds are likely most limited by fall migration habitat, thus this period should be emphasized for mitigation. Managing the moist soil units for fall migratory shorebirds severely limit the production of waterfowl foods.

(v) A tremendous number of DUDs mitigation in dependent on the moist soil units. Productivity of these units will only be maintained at the level proposed if proper operation and maintenance is applied at a cost of over 13 million dollars during the 50 years of this project. Furthermore, moist soil units only produce foods at the level indicated in the model when they are appropriately managed by an individual properly trained in wetland management. There is no indication who will finance or provide the manpower for this O&M.

(vi) There is no indication the Corps is considering decreases in the value and function of jurisdictional wetlands. As mentioned above, waterfowl require a minimum and maximum water level for habitat to be of beneficial. This project will undoubtedly reduce flooding on agricultural habitats that do not meet the criteria as being cropped wetlands, thus, there will be a considerable amount of lost waterfowl habitat that will not be mitigated. Additionally, hydrology will be reduced in jurisdictional wetlands to a level that may not cause them to lose their jurisdictional status, but will certainly decrease their function and value at providing waterfowl habitat. Again, there is no indication this loss of habitat will be mitigated.

(vii) Habitat diversity must be considered when mitigating habitat for waterfowl. Habitat requirements vary considerably even among dabbling ducks. Some species require more open habitat (e.g., northern shovelers and northern pintails), while others prefer wooded habitats (e.g., mallards and wood ducks), while still other prefer and intermediate type habitat such as moist soil units (e.g., blue and green winged teal) during spring migration. While the panel believes food resources depicted as DUDs is the most appropriate metric to measure habitat impacts, these DUDs need to be spread over a diversity of habitats to properly mitigate for all species.

Significance – High:

It appears none of the 4 mitigation alternatives will properly mitigate wetland loss for waterfowl; lack of appropriate mitigation will prevent the project from moving forward.

Recommendations for Resolution:

To resolve these concerns, project needs to consider the following:

- Base waterfowl mitigation criteria on mitigating for not only lost wetlands but the loss of wetland and value function for waterfowl during the spring migratory period.
- Ensure forested mitigation wetlands are inundated by water at the appropriate level for use by ducks.
- Include estimates of loss of value and function of wetlands when estimating mitigation requirements.
- Base mitigation plan on loss of spring migratory not winter habitat.
- Update WAHM model with more recent parameter estimates and incorporate the greater energetic cost of migration as well as the need for waterfowl to acquire nutrient reserves during spring migration.
- Provide a long term (50 year) plan for managing moist soil units.
- Provide multiple habitat types in the mitigation plan.

Comment 20:
The structure of the Consolidated NEPA Document is difficult to follow, the presentation of analyses and conclusions is uneven, and the study references are lacking or outdated, all of which make it difficult for the panel to properly evaluate the report's findings and conclusions.
Basis for Comment:
The panel found the Consolidated NEPA Document difficult to read and evaluate because of its complicated structure, uneven level of analysis, and inconsistent numbering of alternatives. The complicated structure derives from the fact that the report is a revision of a supplement and therefore frequently references previous analyses rather than describing them clearly. The panel believes the document would be improved by (1) including a narrative comparison of the impacts to supplement Table 2.3 Comparative Impacts of Alternatives on p. 26, (2) ensuring that the numbering of the alternatives reflects the relationships among alternatives and is consistent throughout all the appendices, and (3) adding relevant citations and updating those that are 20-30 years old. A specific example of the confusing numbering of alternatives is as follows: the list of alternatives mentioned in the footnote on Appendix C, p. C-3, notes that "Options 1, 2, and 3 are denoted on Appendix A, Figure 2, as alternatives 3-1, 3-2, and 3-3, respectively. Also, Options 4 and 5 are denoted as alternatives 7-2 and 7-3, respectively." There is no clear reason for the different numbering systems, and standardizing the list of alternatives throughout the project, including the Revised New Madrid Floodway Terrestrial Habitat Evaluation Procedures, would substantially improve the clarity of the documents.
Significance – Medium:
The complexity of the document, its uneven treatment of different issues, and its lack of recent citations adversely affect the ability of readers to understand the analysis and evaluate the conclusions.
Recommendations for Resolution:
To resolve these concerns, the project needs to consider the following: ▪ The panel assumes that the document under review will not be revisited, but recommends that any future document be written in a way that does not include the complicated structure and redundant material in this document. ▪ The panel recommends that the alternatives be named and numbered in a way that clearly shows their relationship with each other, making it easier to follow subsequent analyses. ▪ The panel recommends that each resource of concern receive the level of analysis commensurate with the anticipated impacts (e.g., information on the dominant species and the different types of floodplain habitat should be included since they are important to the life-history stages and communities of fishes that will be significantly affected by the alternatives) and include the most recent and relevant citations.

Comment 21:
The economic analysis is missing key assumptions used in flood reduction projects, such as injuries avoided and lives saved from flooding.
Basis for Comment:
The current Consolidated NEPA Document states the possibility of flood reduction in communities where people live; however, it provides no quantitative analysis of the economic benefits that pertain to flood risk reduction in those communities other than for some of the alternatives (e.g. for Alternative 4, street and road benefits, p. B-18, Appendix B). A range of economic and quantifiable benefits have been associated with risk reductions for low to high flooding conditions in other studies and for other contexts (regions) that pertain to lives saved, injuries avoided, commuting delays avoided. The report needs to clarify whether such benefits as avoided commuting delays are included in the "damage rate per mile" (p. B-18 of Appendix B), and if not, why an analysis like this is absent for this region and project. Flooding causes delays, at the very least, in commuting to work, school, or for emergency trips, etc. The literature in economics suggests that time savings can be substantial and a common approach in the transportation economics literature {e.g., Brownstone and Small. (2005)} is to calculate the amount of time saved and multiply this by some fraction of the wage rate. At worst, flooding could lead to deaths from drowning or from blocked roads that make emergency trips to hospitals impossible. References Brownstone, D., Small, K.A. (2005). Valuing time and reliability: assessing the evidence from road pricing demonstrations, *Transportation Research A*, 39(4), 279-293..
Significance – Medium:
As economic benefits associated with community flood-related losses are absent in the report, this lowers the benefit-cost ratio for the project.
Recommendations for Resolution:
To resolve these concerns, the project needs to consider the following: ▪ Clarify why the benefits associated with reduced flooding and flood risk is not calculated as they relate to the project. If they simply do not arise because of the project, make clear why they do not. ▪ If these benefits exist, but simply have not been calculated, then a future report should make an effort to estimate the economic benefits associated with lives saved, or injuries avoided, and/or the time saved due to increased reliability of regional transportation and less need to manage minor flooding events at homes in the communities.

Comment 22:
It is unclear how the proposed change in the condition of Big Oak Tree State Park will mitigate loss of wetlands and other habitat in the project.
Basis for Comment:
Big Oak Tree State Park (BOTSP) provides habitat for some of the nation's champion bottomland trees (Appendix L, page 15) and thus, this is potentially an important resource for not only the state, but for the nation. The Consolidated NEPA Document does not clearly indicate how the project will change ecological conditions at BOSP, and the panel is unsure if the proposed mitigation plan is possible to implement. The Consolidated NEPA Document references potential re-flooding of BOTSP for mitigation (p. 39 and Appendix L), but does not document the impacts of the original project goals that are designed to reduced flooding. The exact changes at BSOTP due to managing hydrological conditions might help mitigate losses of wetlands at other areas, but the current report does not document the current ecological trends at the BSOTP carefully nor does the report predict future conditions after the river flooding mitigation of BOTSP (p. 38-39). Economic benefits are among the potential positive impacts from the proposed mitigation, as there is anticipated to be an increase in park attendance. Visitation to BSOTP is a form of recreation, and non-visitors might also have some willingness to pay for protection of the species there even when they do not go. There is no detailed discussion of either of these potential benefits in the current Consolidated NEPA Document. The economics literature that provides estimates of the values and increases in recreation at forests, as well as estimates of willingness to pay for protection of forest stands that might be unique, is relatively large. No mention of that literature appears in the current report/revisions.
Significance – Medium:
Big Oak Tree State Park is potentially an important resource for not only the state, but for the nation, and benefits of improvements there could change the estimated BC ratio, possibly increasing the benefits.
Recommendations for Resolution:
To resolve these concerns, the project needs to consider the following: ▪ Evaluate existing ecological conditions and trends at Big Oak Tree State Park, to support the claim that there is drying, and that this indeed may harm current species and habitat if the trend continues. ▪ If the above evaluation of the project's mitigation strategy determines that habitat will be improved, then a long-term (15-50 year) monitoring program should be designed to track those changes. ▪ Revise the economic analysis to include estimates of future visitation increases that might accompany positive resource changes, as well as possible economic benefits that are simply associated with protection of the species. This additional analysis could be prepared by using the method of unit day values for recreation, or benefits transfer for forest protection (using estimates for another similar site).

Comment 23:
The analysis of water quality impacts in the Consolidated NEPA Document did not meet the objectives of the study.
Basis for Comment:
A stated objective of the water quality analysis in the Consolidated NEPA Document is to quantify the effects of hydrologic changes on water quality for both the area impacted by the proposed project and in relationship to the overall water quality of the Mississippi River. The methods used to meet this objective (Appendix I) were based on the relative transport/retention of nutrients, organic carbon and sediments associated with various hydrologic events based on selected surface water elevations. Hydrologic data and land cover data were used in conjunction with water quality data to conduct mass balances for various scenarios associated with the project. The water quality analysis in the document fails to meet either part of the stated objective for two reasons. First, the mass balances conducted do not represent water quality conditions in any of the waterbodies in the project area (St. Johns Bayou and New Madrid Floodway) under current conditions or with the proposed project, but only the total amounts of mass transported or retained. Second, these mass balances did not compare nutrient loads from the project area to the Mississippi River under current conditions to those under the proposed project. These balances compared nitrogen removal efficiencies at an assumed water surface elevation of 290 feet NGVD between current conditions and with mitigation associated with restored acreage. None of the five hydrologic scenarios in the report was the actual project because each of them involved the same flooded acres at 290 feet NGVD, whereas the proposed project involves blocking the water level beyond 284.2 feet NGVD in the New Madrid Floodway. The water quality analysis in the report tends to diminish the potential impacts of the proposed project. The nutrient loads from the project area, however they are determined, will always be a small fraction of the total nutrient loads in the mainstem of the Mississippi River, hence none of the project alternatives will substantially change current water quality conditions on the basis of this metric alone. What have not been adequately addressed in the water quality analysis are potential impacts of the proposed project on local water quality within the St. Johns Bayou and New Madrid Floodway. The water quality analysis in the report did not consider the potential impacts of the proposed project on suspended sediment in Spillway Ditch, St. Johns Bayou. This system is listed as impaired by the State of Missouri under Section 303(d) of the Clean Water Act because the water quality standards were exceeded due to sediment. The primary cause of the sediment impairment was identified as pollution caused by agricultural non-point sources. A total maximum daily load (TMDL) was approved by U.S. EPA on November 22, 2006, that established the maximum allowable amount of sediment load to Spillway Ditch from non-point sources. The impacts of the proposed project on suspended sediment loads to Spillway Ditch were not investigated to determine whether they will exceed this maximum allowable load. Another issue is that the report's estimate of denitrification rates on farmed wetlands was based on values from the literature (Ochs and Milburn 2003) that were later discovered to be erroneous

and that were subsequently corrected by the senior author (Ochs 2006). The corrected rates are three orders of magnitude higher than those in Ochs and Milburn (2003). The report did not use these erroneous denitrification rates in the mass balance analysis in Appendix I, but used them in Appendix M, Page 461, to support the assertion that this analysis does not likely underestimate the nitrogen removal on flooded crop fields. When the corrected rates are used, it appears likely that the mass balance analysis is underestimating the nitrogen removal on flooded crop fields. The significance of this apparent underestimation is that greater compensatory mitigation might be required to offset the lost nitrogen removal capacity on these fields because they would no longer be regularly flooded with the proposed project. References Ochs, C.A. and S.A. Milburn. 2003. Effects of simulated wintertime flooding to control erosion on selected chemical and microbial properties of agricultural soils in the Mississippi Delta. *Journal of the Mississippi Academy of Sciences* 48:102-114. Ochs, C.A. 2006. Corrections to denitrification measurements. *In* C.A. Ochs and S.A. Milburn (eds.), With a revised view of the importance of denitrification to N-loss from agricultural soils of the Mississippi Delta. *Journal of the Mississippi Academy of Sciences* 51:177-179.
Significance – Medium:
The Consolidated NEPA Document's conclusion that water quality in both basins (St. Johns Bayou and New Madrid Floodway) is expected to remain unchanged is not supported by the analysis in the report because this analysis did not include investigations of local water quality in either basin under the actual proposed project.
Recommendations for Resolution:
To resolve these concerns, the project needs to consider the following: ▪ Conduct a quantitative assessment of the impacts of the actual proposed project on waterbodies in the St. Johns Bayou and New Madrid Floodway. ▪ Investigate the impacts of the proposed project on suspended sediment load to Spillway Ditch and on the sediment TMDL. ▪ Re-investigate the nitrogen removal on flooded crop fields in the mass balance analysis and re-consider the compensatory mitigation that might be required to offset the lost nitrogen removal capacity on these fields with the proposed project

Comment 24:

The planned project monitoring for water quality lack key elements and sufficient detail to satisfy U.S. EPA guidance.

Basis for Comment:

The planned project monitoring for water quality is described in only two short paragraphs (Sections 7.2 and 6.5) in the Consolidated NEPA Document. Missing from the document are key elements including strategy, objectives, design, quality assurance, data management, data analysis and assessment, and reporting. These are all basic elements of state water monitoring and assessment programs and are contained in published U.S. EPA guidance (EPA 2003). These elements are all relevant to the planned project monitoring goals for water quality for the proposed project.

References

U.S. Environmental Protection Agency (USEPA). 2003. Elements of a State Water Monitoring and Assessment Program. Assessment and Watershed Protection Division, Office of Wetlands, Oceans and Watersheds. EPA 841-B-03-003. Washington, DC.

Significance – Medium:

Without a well-formulated water quality monitoring plan, it will not be possible to determine whether water quality in the St. Johns Bayou and New Madrid Floodway is adversely impacted by the proposed project.

Recommendations for Resolution:

To resolve these concerns, the project needs to consider the following:

- Develop a water quality monitoring plan for the proposed project that includes an overall strategy, objectives, design, quality assurance, data management, data analysis and assessment, and reporting, consistent with the U.S. EPA (2003) technical guidance.

Comment 25:
Economic impacts that could be cancelled out in other regions should not be included in a Benefit-Cost (BC) analysis or economic analysis for a project that focuses on national economic development.
Basis for Comment:
Several parts of the Consolidated NEPA document and parts of Appendix B (starting at p. B43 and through p. B.53-B56) deal with economic impacts on the local communities in the project area. These impacts include descriptions of how local economic conditions might improve with the project, focusing on regional income and employment, and describing these as benefits of a national/federal project. A federal project is typically evaluated from the perspective of the nation, leading to "net national economic value." From the national accounting stance, only those benefits that do not arise at the expense of benefits in other regions of the country would pertain to a Benefit-Cost (BC) analysis. It is not clear whether local, rather than national benefits, have been included in the calculations of the BC ratios in Table 19 (Appendix B, p. B-25). For example, projects such as this one produce jobs in building the project facilities and infrastructure, and create jobs for support of the workers, all leading to multiplier impacts on regional economies. The multiplier concept describes how a single dollar of income or spending can generate more than one dollar of spending. By example, if Worker A earns $1 in income and then spends it on food at a restaurant, this means the cook gets another dollar in income, and can then turn around and spend it on something else, etc. Income and wages to the workers are often seen as a local economic benefit, especially when there are new jobs. The multiplier impacts are deemed "secondary" impacts and arise from such things as expenditures that the workers make on local food, housing, transportation, etc. Some jobs vanish when construction is completed, but others are created over the life of the project, tied to ongoing operations and management. However, all of these jobs might be filled by workers that are imported from other regions. If Region A, the project region, gains jobs and income, but Region B loses jobs, and therefore also suffers economically, then the two impacts cancel each other out, and a national accounting of the impacts would show no net gain. In contrast, an area that has high unemployment, and which is regionally unique in this regard, might staff or fill the jobs with unemployed workers within the region, adding income for those workers and some secondary impacts. Whether the unemployed can fill jobs is often a case of whether there is a match in the skills needed, and those skills that existing unemployed workers can provide. Analysis must show this is the case, or all local and regional economic impacts cannot be included in the national benefit-cost analysis.
Significance – Medium:
All benefits categories must clearly be shown to be only national impacts for the benefits used in calculating the BC ratios that appear in Table 19 of the Consolidated NEPA Document and other similar tables.

Recommendations for Resolution:
To resolve these concerns, the project needs to consider the following: ▪ Evidence that local and regional economic impacts do not come at the expense of losses in other parts of the state, or region, or another state, and if so, analysis of these clear economic benefits. Documentation would include a detailed assessment of employment in the region and outside of it, including skills that unemployed people have, and would need to have in the future. In addition, migration patterns should be well documented, showing demographic changes expected for the region. ▪ If the evidence cannot be demonstrated that benefits are national in scope and not offset by losses in other regions, then a new report might add a separate appendix, including "local" or "regional" primary and secondary economic impacts, but these benefits cannot be included in the analysis of national economic impacts.

Comment 26:
Uncertainties in the hydrologic, hydraulic, and economic studies could be analyzed and presented in a more detailed and meaningful manner using methodologies incorporated in the HEC-FDA Flood Damage Reduction Analysis modeling system.
Basis for Comment:
USACE policy requires incorporation of relatively new uncertainty analysis methods in flood risk reduction analysis procedures that explicitly consider uncertainty by expressing various inputs with probability descriptors. In flood hydrology studies, probability descriptors represent the uncertainties in estimating flow rates and durations associated with specified exceedance frequencies. In hydraulic studies, probability descriptors model the uncertainties involved in estimating flow depths resulting from specified flow rates. In economic evaluations, probability descriptors are formulated to describe uncertainties in estimating economic damages to result from specified flood stages and durations. Methods for dealing with uncertainties were developed at the USACE Hydrologic Engineering Center (HEC) and elsewhere during the 1990's and have been implemented Corps-wide. The uncertainty analysis methods expand on and are incorporated within the older conventional evaluation procedures. Methods for explicitly considering uncertainties in hydrologic, hydraulic, and economic analyses are incorporated in the latest (1998) version of the HEC-FDA Flood Damage Reduction Analysis software. Both conventional and the newer uncertainty-based analysis methodologies were adopted in the hydrologic, hydraulic, and economic evaluations presented in Appendices B and C of the Consolidated NEPA Document. However, the capabilities afforded by the newer uncertainty-based methodologies for presenting analysis results are not fully utilized. A basic reason for explicitly incorporating uncertainty in an analysis is to be able to express the results probabilistically. For example, the ratio of economic benefits to costs are presented in the Consolidated NEPA Document in the traditional format of a single number such as 1.10, meaning the benefit-to-cost ratio (BCR) is estimated to be 1.10 for a particular plan. Alternatively, a BCR could be viewed probabilistically. A report could state that, due to many complexities, the BCR is not known with certainty. However, there is an estimated "x" percent probability that the BCR is above 1.0 and a "y" percent probability that the BC ratio is below 1.0. Likewise, the report could present the estimated likelihoods that the BC ratio exceeds 1.10 and other levels. The effects of uncertainties on the component estimates of flows, stages, and damages upon which the economic benefits are based can be displayed using HEC-FDA tools. Strategies for expanding the use of uncertainty analysis methods in the various assessments presented in the Consolidated NEPA Document should be developed and applied.
Significance – Medium:
More detailed analyses and display of uncertainties will enhance the completeness of the report and facilitate a more thorough understanding of study results.
Recommendations for Resolution:
To resolve these concerns, the project needs to consider the following: ▪ Apply the uncertainty modeling capabilities incorporated in HEC-FDA and organize the results of the hydrologic, hydraulic, and economic analyses to more meaningfully display modeling/data uncertainties and their effects on the study results and conclusions.

Comment 27:
Given the goals of the Gulf Hypoxia Action Plan 2008, Alternative 8 in the Consolidated NEPA Document should be reframed as a "nutrient farming" alternative.
Basis for Comment:
The Gulf Hypoxia Action Plan 2008 calls for a 45 percent reduction in nitrogen and phosphorus loads delivered to the Gulf of Mexico to achieve the coastal goal for reduction in the size of the hypoxic zone ("dead zone") in the Gulf, and to improve water quality within the Mississippi River Basin. The Consolidated NEPA Document acknowledges that removal of cropland from production and reforesting will reduce nitrogen available to the Gulf of Mexico by: (1) reducing fertilizer applications; (2) improving nitrogen removal from runoff in the project area; and (3) improving removal of nitrogen from the Mississippi River during periods of backwater flooding on the mitigation sites when flooded. The report also acknowledges that bottomland hardwoods have higher habitat value for fish than cropland. Under Alternative 8, frequently flooded agricultural land in the St. Johns Bayou and New Madrid Floodway would be converted to silviculture and would require changing several thousand acres from agricultural production to forest through the Wetland Reserve Program (WRP) or other similar mechanisms. The Consolidated NEPA Document stated that while the WRP has been available to landowners for many years, few have chosen to participate, thus apparently ruling out this alternative for detailed analysis. The apparent rationale for ruling out Alternative 8 was flawed because it did not include economic incentives based on nutrient trading but only those based on the Wetland Reserve Program and other, unspecified mechanisms. Nutrient trading is a market-based approach for improving water quality that involves two basic steps: (1) a goal (or percent reduction) for the total amount of nutrients that can be delivered to a waterbody; and (2) allowing sources to trade in ways that meet local and watershed-wide water quality goals. Once nutrient sources are allocated, sources with low-cost pollution reduction options have an incentive to reduce nutrient loadings beyond what is required of them and to sell the excess credits to sources with higher control costs. Greenhalgh and Faeth (2001) conducted an economic and environmental policy analysis to assess how the agricultural community could better reduce its contribution to the Gulf of Mexico "dead zone." Using a sectoral model of U.S. agriculture, they compared policies including untargeted conservation subsidies, nutrient trading, Conservation Reserve Program extension, agricultural sales of carbon and greenhouse gas credits, and fertilizer reduction. They concluded that nutrient trading strategies produce greater all round benefits for the environment and for farm returns than traditional policy approaches. The Consolidated NEPA Document used a traditional land valuation approach to assess the possible benefits of land use changes such as converting agricultural lands to silviculture. The report also considered the use of incentives provided for under the WRP and other, unspecified

incentives, but did not contain any analysis of incentives based on nutrient trading. References Greenhalgh, S. and P. Faeth. 2001. A water quality strategy for the Mississippi River Basin and the Gulf of Mexico. *American Agricultural Economics Association Meeting* 2001.
Significance – Medium
The investigation of Alternative 8 is incomplete because it did not include consideration of relevant economic factors that would have provided a more complete understanding of its environmental and economic benefits, hence resulting in retention of Alternative 8 for more detailed analysis.
Recommendations for Resolution:
To resolve these concerns, the project needs to consider the following: ▪ Re-frame Alternative 8 as a "nutrient farming" alternative and re-evaluate the economic incentives based on nutrient trading. ▪ Evaluate potential nutrient trading options with both point source dischargers and other nonpoint sources in the Mississippi River Basin. ▪ Coordinate this investigation of nutrient trading with the Mississippi River/Gulf of Mexico Watershed Nutrient Task Force.

Comment 28:
It is not clear from the Consolidated NEPA Document if adequate resources are available for adaptive management to be successfully applied at mitigation areas, and adaptive management plans are not described in sufficient detail.
Basis for Comment:
Adaptive management is a useful approach to managing uncertainty when significant resources are available for monitoring post project environmental conditions, and when resources are also available to conduct substantial mid course corrections in project design and implementation. The monitoring necessary to determine if the wetlands and other habitats proposed as mitigation for project impacts on shorebirds, waterfowl, and fish are adequately replacing lost habitat functions is considerable, and it is not clear if adequate resources are available for adaptive management to be successfully applied. Impacts from the project on shorebirds are likely to be significant, and will occur in a region that is critical for maintaining shorebird populations during annual migration (Skagen et al. 2008). Monitoring of shorebird impacts for at least 15 years is a critical aspect of determining whether mitigation planning and implementation was successful. Table 6.1 in the Consolidated NEPA Document does not mention monitoring for shorebird use, other than the general phrase "other biological monitoring" (p. 240). The most reliable metric of shorebird use is direct counts through the migration season, and the collection of detailed data requires careful project design (Farmer and Durbian 2006). The monitoring plan should be designed to provide the data necessary to determine whether mitigation areas are providing the required level of function. In addition, the plan should specify the resources that will be available for correcting any problems that arise, and the commitment to carry them out. Direct counts of shorebird numbers, following modern techniques that include measures of detection rates, should be included, and funding for carrying out these counts should be included in the overall cost estimates of the mitigation plan. Mitigation for waterfowl is based on creating or restoring wetlands that produce an appropriate level of invertebrates and moist soil seeds. Thus, the adaptive management approach to monitoring the success of mitigation for waterfowl should emphasize the monitoring of moist soil seed and invertebrate production and biomass in mitigation wetlands. Monitoring should continue for a minimum of 15 years to ensure wetlands are being maintained at the appropriate successional stage. For fishes, no detailed monitoring parameters or end point levels for measuring progress/success are provided in the Consolidated NEPA Document. The HEP and mitigation teams need to develop a specific adaptive approach that incorporates monitoring fish access and use (spawning and rearing) in each of the mitigation habitats. Specific monitoring considerations should include HSI values, habitat transition times, optimum water inundation conditions for spawning and rearing, reference species, fish access, species richness and diversity, river connectivity, and monitoring time-frame. For wetlands, the normal monitoring period is often 5 years after mitigation sites have been created or restored, but this has been considered too short (see e.g., Mitsch and Wilson 1996), and the panel recommends an adaptive management monitoring period of at least 15 years for

marshes or mudflat wetlands and for the entire project duration of 50 years for bottomland hardwood forest mitigation sites. There is little description in the Consolidated NEPA Document on any triggers that might put an adaptive management plan into effect during the monitoring period. There is no description of the adaptive management plan or which agency would be responsible for it after the monitoring period ends.

The Consolidated NEPA Document also suggests that mitigation areas may be turned over to state agencies for long term management. However, it is the panel's opinion that most state agencies are critically short of funds to manage existing state lands. It is questionable whether the state would have the resources to manage these additional areas in perpetuity. In particular, management of the moist soil units requires ongoing input of human resources for monitoring, determining management techniques, and implementing management efforts, along with substantial direct costs in materials and equipment. In particular, the mitigation plan will fail to adequately compensate for project impacts if the moist soil units are not managed extensively in perpetuity, which represents a substantial cost of the project. The costs of adaptive management should be included in calculations of the total cost of the project, on an ongoing basis as part of the operation of the project itself, or the planned management of the mitigation areas will likely be inadequately implemented due to resource constraints.

References

Farmer, A. and F. Durbian. 2006. Estimating Shorebird Numbers at Migration Stopover Sites. *The Condor* 108:792-807.

Mitsch, W.J. and R.F. Wilson. 1996. Improving the success of wetland creation and restoration with know-how, time, and self-design. *Ecological Applications* 6:77-83.

Skagen, S. K., D. A. Granfors, and C. P. Melcher. 2008. On Determining the Significance of Ephemeral Continental Wetlands to North American Migratory Shorebirds. *The Auk* 125:20-29.

Significance – Medium:

Providing adequate resources to implement ongoing adaptive management and monitoring are critical to successful execution of the mitigation plan.

Recommendations for Resolution:

To resolve these concerns, the project needs to consider the following:

- Conduct an adaptive management study, including a field-based monitoring system for fish and wildlife use of mitigation areas, and a source of support for monitoring over at least 15 years and management in perpetuity to ensure that mitigation areas continue to provide suitable habitat.
- The adaptive management plan for shorebirds should include ongoing direct counts of shorebirds at mitigation sites for at least 15 years, including measurements of detection rates, the source of support for monitoring, and plans for mid-course corrections if adequate habitat is not being provided.
- The adaptive management plan for waterfowl should include monitoring of moist soil seed and invertebrate production and biomass in mitigation wetlands for a minimum of 15 years.
- The adaptive management plan for fish should include monitoring fish access and use for both spawning and rearing in each of the mitigation areas for 15 years, and measurement of HSI values, habitat transition times, optimum water inundation conditions for spawning and rearing, reference species, species richness and diversity, and river connectivity.

- The adaptive management plan for wetland mitigation sites should include a 15 year timeframe for marshes and the full project duration of 50 years for the bottomland hardwood forests, specify the measures of ecological function that will be monitored, and specify the conditions that would trigger implementation of adaptive management to meet plan objectives if conditions are below target thresholds.

List of Comment References

Altor, A.E. and W.J. Mitsch. 2008. Pulsing hydrology, methane emissions, and carbon dioxide fluxes in created marshes: A 2-year ecosystem study. *Wetlands* 28:423-438.

Anderson, C.J. and W.J. Mitsch. 2008. The influence of flood connectivity on bottomland forest productivity in central Ohio, USA. *Ohio J. Science* 108 (2): 2-8.

Bingswanger, H.P. 1981. Attitudes toward risk: Theoretical implications of an experiment in rural India. *The Economic Journal* 91 (364):867-90.

Council on Environmental Quality. 1997. Considering Cumulative Effects under the National Environmental Policy Act. Washington, D.C. January 1997.

Cross, D., and P. Vohs, (eds). 1988. Waterfowl Management Handbook. Fort Collins, CO: U.S. Fish and Wildlife Service.

Farmer, A. and F. Durbian. 2006. Estimating Shorebird Numbers at Migration Stopover Sites. *The Condor* 108:792-807.

Farmer, A. H. and J. A. Wiens. 1999. Models and reality: Time-energy trade-offs in Pectoral Sandpiper (Calidris melanotos) migration. *Ecology* 80:2566-2580.

Fink, D.F. and W.J. Mitsch. 2007. Hydrology and biogeochemistry in a created river diversion oxbow wetland. *Ecological Engineering* 30:93-102.

Frederick, S., G. Loewenstein and T. O'Donoghue. 2002. Time Discounting and Time Preference: A Critical Review. *J. of Econ. Literature* Vol. XL, June:351-401.

Greenhalgh, S. and P. Faeth. 2001. A water quality strategy for the Mississippi River Basin and the Gulf of Mexico. *American Agricultural Economics Association Meeting* 2001.

Hands, H.M., M. R. Ryan, and J.W. Smith. 1991. Migrant shorebird use of marsh, moist-soil, and flooded agricultural habitats. *Wildlife Society Bulletin* 19:457-464.

Helmers, D. 1992. Shorebird Management Manual. Western Hemisphere Shorebird Reserve Network Manomet, MA. 58p.

Hernandez, M.E. and W.J. Mitsch. 2006. Influence of hydrologic pulses, flooding frequency, and vegetation on nitrous oxide emissions from created riparian marshes. *Wetlands* 26:862-877.

Hernandez, M.E. and W.J. Mitsch. 2007. Denitrification in created riverine wetlands: Influence of hydrology and season. *Ecological Engineering* 30:78-88.

Laubhan, M.K., and L.H. Fredrickson. 1993. Integrated Wetland Management: Concepts and Opportunities. Special Session 6 of Wetland Management for Shorebirds and Other Species. *In* G.H. Finney and G. Castro. (eds.) *Transactions of the 58th North American Wildlife and Natural Resources Conferences,* Wildlife Management Institute.

Laubhan, M. K. 1995. Effects of prescribed fire on moist-soil vegetation and soil macronutrients. *Wetlands* 15:159-166.

Lehnen, S. E., and D. G. Krementz. 2005. Turnover Rates of Fall-Migrating Pectoral Sandpipers in the Lower Mississippi Alluvial Valley. *Journal of Wildlife Management* 69:671-680.

Loesch, C.R., D. J. T., K. Tripp, W.C. Hunter, and M.S. Woodrey. 2000. Development of Management Objectives for Waterfowl and Shorebirds in the Mississippi Alluvial Valley, Pages 8-11. *In* D. P. R. Bonney, R.J. Cooper and L. Niles, (eds.), Strategies for Bird Conservation: The Partners in Flight Planning Process, *Proceedings of the 3rd Partners in Flight Workshop*, 1995 October 1-5, Cape May, NJ. U.S. Department of Agriculture, Forest Service, Rocky Mountain Experiment Station, Ogden UT.

Mitsch, W.J. and R.F. Wilson. 1996. Improving the success of wetland creation and restoration with know-how, time, and self-design. *Ecological Applications* 6:77-83.

Mitsch, W.J., L. Zhang, C.J. Anderson, A. Altor, and M. Hernandez. 2005. Creating riverine wetlands: Ecological succession, nutrient retention, and pulsing effects. *Ecological Engineering* 25:510-527.

Mitsch, W.J., L. Zhang, D.F. Fink, M.E. Hernandez, A.E. Altor, C.L. Tuttle and A.M. Nahlik. 2008. Ecological engineering of floodplains. *Ecohydrology & Hydrobiology* 8:139-147.

Ochs, C.A. and S.A. Milburn. 2003. Effects of simulated wintertime flooding to control erosion on selected chemical and microbial properties of agricultural soils in the Mississippi Delta. *Journal of the Mississippi Academy of Sciences* 48:102-114.

Ochs, C.A. 2006. Corrections to denitrification measurements. *In* C.A. Ochs and S.A. Milburn (eds.), With a revised view of the importance of denitrification to N-loss from agricultural soils of the Mississippi Delta. *Journal of the Mississippi Academy of Sciences* 51:177-179.

Pankau, A. K. 2008. Examining cost effectiveness of actively and passively managed wetlands for migrating and wintering waterfowl in Southern Illinois. M.S. Thesis. Southern Illinois University Carbondale.

Peterson, S.B., J.M. Teal, and W.J. Mitsch (eds.) 2005. Delaware Bay Salt Marsh Restoration. Special Issue of *Ecological Engineering* 25: 199-314.

Skagen, S. K., D. A. Granfors, and C. P. Melcher. 2008. On Determining the Significance of Ephemeral Continental Wetlands to North American Migratory Shorebirds. *The Auk* 125:20-29.

Tuttle, C.L., L. Zhang, and W.J. Mitsch. 2008. Aquatic metabolism as an indicator of the ecological effects of hydrologic pulsing in flow-through wetlands. *Ecological Indicators* 8: 795-806.

Twedt, D. J., C. O. Nelms, V. E. Rettig, and S. R. Aycock. 1998. Shorebird Use of Managed Wetlands in the Mississippi Alluvial Valley. *The American Midland Naturalist* 140:140-152.

U.S. Environmental Protection Agency (USEPA). 2003. Elements of a State Water Monitoring and Assessment Program. Assessment and Watershed Protection Division, Office of Wetlands, Oceans and Watersheds. EPA 841-B-03-003. Washington, DC.